

*This application claims priority for Australian provisional  
patent application No. PS1606, filed on 8th April 2002*

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THERAPEUTIC METHOD

FIELD OF THE INVENTION

5 This invention relates to the use of an antagonist  
of a G protein-coupled receptor in the prevention and/or  
treatment of fibrosis, such as the treatment of fibrosis  
associated with myocardial infarction, diabetes, or certain  
pulmonary conditions. In a preferred embodiment the  
10 antagonist is a C5a receptor antagonist, more preferably a  
cyclic peptide antagonist of the C5a receptor.

BACKGROUND OF THE INVENTION

15 All references, including any patents or patent  
applications, cited in this specification are hereby  
incorporated by reference. No admission is made that any  
reference constitutes prior art. The discussion of the  
references states what their authors assert, and the  
applicants reserve the right to challenge the accuracy and  
20 pertinency of the cited documents. It will be clearly  
understood that, although a number of prior art  
publications are referred to herein, this reference does  
not constitute an admission that any of these documents  
forms part of the common general knowledge in the art, in  
25 Australia or in any other country.

G protein-coupled receptors are prevalent  
throughout the human body, comprising approximately 60% of  
known cellular receptor types. They mediate signal  
transduction across the cell membrane for a very wide range  
30 of endogenous ligands and consequently participate in a  
diverse array of physiological and pathophysiological  
processes, including, but not limited to, those associated  
with cardiovascular, central and peripheral nervous system  
reproductive, metabolic, digestive, immunoinflammatory, and  
35 growth disorders, as well as other cell regulatory and  
proliferative disorders. Agents which selectively modulate

et al. 1997).

The effects of drug-induced and hypertension-induced pulmonary and renal fibrosis in animal models can be prevented or partially reversed by compounds which act  
5 by suppressing inflammatory events and down-regulating lung pro-collagen I over-expression (Iyer et al., 1999a,b).

We have shown that the administration of pirfenidone or spironolactone can prevent and partially reverse cardiac fibrosis and the increase in cardiac  
10 stiffness which occurs in streptozotocin-induced diabetes in rats (Miric G, et al., 2001) It is thought that pirfenidone acts by inhibiting increased TGF- $\beta$  mRNA expression, allowing an increase in expression of metalloproteases which degrade the collagen I laid down  
15 during fibrosis. The mode of action of spironolactone is at present unknown. Spironolactone is a steroid analogue which is primarily used as a diuretic; pirfenidone (5-methyl-1-phenyl-2-(1H)-pyridone), an investigational compound being investigated as an anti-fibrotic agent in a  
20 number of indications.

It would be highly desirable to identify other therapeutically or prophylactically active agents for use in the treatment or prevention of fibrosis.

6x  
p6  
25 { The overexpression or underregulation of a G-protein-coupled receptor, the C5a receptor, has been implicated in immune-system mediated events such as inflammation. Agents which influence C5a receptor activity, such as C5a receptor antagonists, have the potential to mediate inflammatory events, and may provide a means of therapeutic or prophylactic intervention, but have not previously been suggested as potential agents in the treatment or prevention of fibrosis.  
30

We have now surprisingly found that a cyclic peptide with C5a receptor antagonist has the ability to  
35 ameliorate cardiac fibrosis in an animal model of this condition.

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SUMMARY OF THE INVENTION

X → for P 5

5 According to a first aspect, the invention provides a method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.

10 The use of any compound having activity as an antagonist of a G protein-coupled receptor, and particularly as a C5a receptor antagonist, is contemplated, including but not limited to those disclosed in our earlier International patent applications No. PCT/AU98/00490 or No. 15 PCT/AU02/01427 or in International patent applications No. PCT/US00/11187 by Neurogen Corporation and No. PCT/JP01/06902 by Welfide Corporation, or antibody antagonists such as those disclosed in PCT/US00/24219 or US patent No. 6355245. The entire disclosures of all of these 20 specifications are incorporated herein by this cross-reference.

25 More preferably the C5a receptor antagonist is a peptide or a peptidomimetic compound, and more preferably is a cyclic peptide or a cyclic peptidomimetic compound. Even more preferably the compound is a cyclic peptide or a cyclic peptidomimetic compound of PCT/AU98/00490 or PCT/AU02/01427.

Still more preferably the antagonist is a compound which

- 30 (a) is an antagonist of a G protein-coupled receptor,  
(b) has substantially no agonist activity, and  
(c) is a cyclic peptide or peptidomimetic compound of formula I

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Xylocaine to prevent airway spasm, the rats were intubated and a slow injection of bleomycin or saline control was completed. The rats were then rotated gently for about 1-2 minutes to allow the solution to diffuse evenly into both  
5 lungs (Christensen et al 2000). Rats were kept in the fume cupboard until totally recovered, and then monitored for up to 18 days. Body weight, food and water intake, and respiration were monitored daily.

Respiration was elevated as follows: Score 0,  
10 normal respiration; Score 1, increased rate of breathing; and Score 2, mouth open respiration. Rats were euthanased before the end of the experimental period, if they consistently lost more than 10% bodyweight for 48 hours,  
15 had Score 2 respiration or had Score 1 respiration for 48 hours.

At the end of this period the rats were killed by exsanguination under anaesthesia, so that the lungs were clear of blood. For each rat, the left lung was immediately frozen in liquid nitrogen and stored at  $-20^{\circ}\text{C}$  for  
20 quantitative collagen analysis using hydroxyproline assay. The right lung was fully inflated and fixed with 10% formulated formalin by airway gravity fixation at a pressure of 30 cm water for 1 minute. Haematoxylin and eosin (H&E) and Picro Sirius Red (PR) staining for collagen  
25 were performed to assess collagen deposition in the lung. For quantitation of collagen stained with PR, polarized light images were converted to grey scale, and the total number of white pixels (specific for collagen) per image was determined as a percentage of the total pixel area. The  
30 procedure was applied to a total of four fields in the alveolar area and two fields in the peribronchial area and blood vessels per sample (Wang et al, 2000). The largest lobe of the right lung (from 4 lobes) in each rat was chosen. The data was analysed using the program "Sion  
35 Image".

Hydroxyproline assay was performed by the method

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Table 1.

Lung weight and body weight in bleomycin-induced pulmonary fibrosis (7-9 days)

5

Condition	Left lung weight (g)	Body weight (g)	Ratio $\times 10^{-3}$
Normal	0.507 $\pm$ 0.003	240.6 $\pm$ 4.667	1.9 $\pm$ 0.36
Bleomycin	1.004 $\pm$ 0.04	226 $\pm$ 8.083	4.47 $\pm$ 0.46**
Bleomycin + PMX53	0.974 $\pm$ 0.132	228 $\pm$ 7.583	4.25 $\pm$ 1.07**

\*\* :  $P < 0.001$ ,  $n=3$ , compared to normal rats.

Under the microscope, numbers of inflammatory cells, including PMNs, macrophages, lymphocytes etc. were observed in the alveolar spaces, with massive leakage of plasma and red blood cells; this is illustrated in Figure 13a. The size and number of type II AECs in the alveolar spaces was clearly increased, as shown in Figure 13b, while in normal lung, the type II AECs covered only 5 - 10% of the surface area of the alveoli, as shown in Figure 14.

There was no significant difference in histology between drug-treated and non-treated groups. Collagen deposition in bleomycin instillation lungs showed a significant increase compared to normal lungs ( $P < 0.01$ ,  $n=3$ ); saline instillation lungs ( $P < 0.01$ ,  $n=3$ ); and saline instillation with PMX53-treated lungs ( $P < 0.01$ ,  $n=3$ ). However, there was no significant difference between the drug-treated group and non-treated group ( $P > 0.01$ ,  $n=4$ ). These results are summarised in Figure 15.

25

## 2. Pulmonary fibrosis

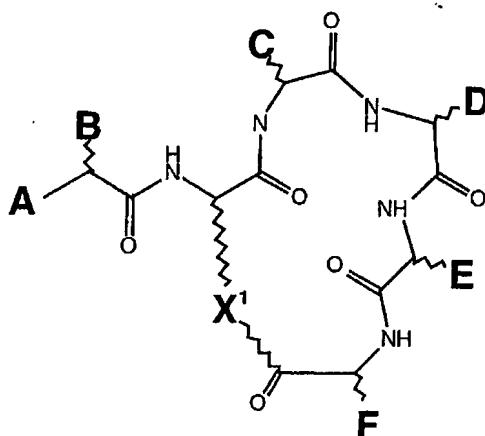
Eighteen days after intra-tracheal instillation of bleomycin, the degree of oedema was reduced in bleomycin-instilled lungs, and the lung/body weight ratio did not

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## MARKED-UP COPIES

CLAIMS

1. A method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of  
 5 administering an effective amount of an antagonist *of a C5a receptor* ~~of a G~~  
~~protein-coupled receptor~~ to a subject in need of such treatment,
2. A method according to claim 1, in which the antagonist is a C5a receptor antagonist.
- 10 ~~3. A method according to claim 1 or claim 2, in which the antagonist is a peptide or a peptidomimetic compound.~~
- 1.2* A method according to claim ~~3~~, in which the antagonist is a cyclic peptide or a cyclic peptidomimetic  
 15 compound.
- 3.3* A method according to ~~any one of claims 1 to 3,~~ *or claim 2*  
 in which the antagonist
- (a) is an antagonist of a G protein-coupled receptor,
- 20 (b) has substantially no agonist activity, and
- (c) is a cyclic peptide or peptidomimetic compound of formula I



where A is H, alkyl, aryl, NH<sub>2</sub>, NH-alkyl,

$N(\text{alkyl})_2$ , NH-aryl, NH-acyl, NH-benzoyl,  $\text{NHSO}_3$ ,  $\text{NHSO}_2$ -alkyl,  $\text{NHSO}_2$ -aryl, OH, O-alkyl, or O-aryl;

B is an alkyl, aryl, phenyl, benzyl, naphthyl or indole group, or the side chain of a D- or L-amino acid  
5 ~~such as L-phenylalanine or L-phenylglycine~~, but is not the side chain of glycine, D-phenylalanine, L-homophenylalanine, L-tryptophan, L-homotryptophan, L-tyrosine, or L-homotyrosine;

C is a ~~small substituent, such as~~ the side chain  
10 of a D-, L- or homo-amino acid such as glycine, alanine, leucine, valine, proline, hydroxyproline, or thioproline, but is ~~preferably not a bulky substituent such as~~ *the side chain of* isoleucine, phenylalanine, or cyclohexylalanine;

D is the side chain of a neutral D-amino acid ~~such~~  
15 ~~as D-Leucine, D-homoleucine, D-cyclohexylalanine, D-homocyclohexylalanine, D-valine, D-norleucine, D-homo-norleucine, D-phenylalanine, D-tetrahydroisoquinoline, D-glutamine, D-glutamate, or D-tyrosine~~, but is ~~preferably not a small substituent such as~~ the side chain of glycine  
20 or D-alanine, a bulky planar side chain ~~such as D-tryptophan~~, or a bulky charged side chain ~~such as D-arginine or D-Lysine~~;

E is a bulky substituent, ~~such as the side chain~~ of an amino acid selected from the group consisting of L-  
25 ~~phenylalanine, L-tryptophan and L-homotryptophan~~, or is L-~~1-naphthyl or L-3-benzothienyl~~ alanine, but is not the side chain of D-tryptophan, L-N-methyltryptophan, L-homophenylalanine, L-2-naphthyl L-tetrahydroisoquinoline, L-cyclohexylalanine, D-leucine, L-fluorenylalanine, or  
30 L-histidine;

F is the side chain of L-arginine, L-homoarginine, L-citrulline, or L-canavanine, or a bioisostere thereof,  
~~ie. a side chain in which the terminal guanidine or urea~~  
35 group is retained, but the carbon backbone is replaced by a group which has different structure but is such that the side chain as a whole reacts with the target protein in the

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same way as the parent group, and

X is  $-(CH_2)_nNH-$  or  $(CH_2)_nS-$ , where n is an integer of from 1 to 4, preferably 2 or 3;  $-(CH_2)_2O-$ ;

$-(CH_2)_3O-$ ;  $-(CH_2)_3-$ ;  $-(CH_2)_4-$ ;  $-CH_2COCHRNH-$ ; or

5  $-CH_2-CHCOCHRNH-$ , where R is the side chain of any common or uncommon amino acid.

*New claim 4*

8. A method according to claim 3, in which A is an acetamide group, an aminomethyl group, or a substituted or unsubstituted sulphonamide group.

10 6. A method according to claim 5, in which A is a substituted sulphonamide, and the substituent is an alkyl chain of 1 to 6, preferably 1 to 4 carbon atoms, or a phenyl or toluyl group.

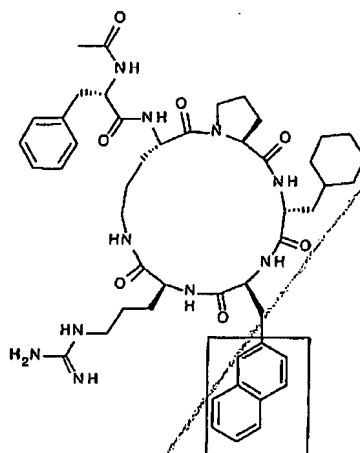
*New claims 7-10*  
8.11 A method according to any one of claims 1 to 6, in which the antagonist is a ~~C5a receptor antagonist~~ <sup>agonist</sup> which has antagonist activity against C5aR, and has no C5a agonist activity.

*New claim*  
8.12 A method according to any one of claims 1 to 7, in which the compound has a receptor affinity  $IC_{50} < 25 \mu M$ , and an antagonist potency  $IC_{50} < 1 \mu M$ .

10.14 A method according to any one of claims 1 to 8, in which the compound is selected from the group consisting of compounds 1 to 6, 10 to 15, 17, 19, 20, 22, 25, 26, 28, 30, 31, 33 to 37, 39 to 45, 47 to 50, 52 to 58 and 60 to 70 described in International patent application No. PCT/AU02/01427.

11.15 A method according to claim 10, in which the compound is ~~PMX53~~ <sup>*Ac F [OP-DCh-WR]*</sup> (compound 1), (compound 33), (compound 60) or ~~Ac F [OP-DCh-WR]~~ <sup>*Ac F [OP-DCh-WR]*</sup> compound 45. *PMX53; Ac F [OP-DCh-WR]*

30 12.16 A method according to claim 10, in which the compound is PMX53, having the formula



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→ 12,

18. A method according to any one of claims 1 to 17,  
in which the fibrotic condition is cardiac fibrosis  
or pulmonary fibrosis.

15  
28 →

23. 18 The use of a C5a receptor antagonist for the  
manufacture of a medicament for use in the treatment of a  
fibrotic condition.

any one of  
as defined in claims 14 to 18

→ 20

29. A method according to claim 18, in which the fibrotic  
condition is cardiac fibrosis or pulmonary fibrosis.

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## PCT REQUEST

Original (for SUBMISSION) - printed on 07.04.2003 02:30:19 PM

FP17710

0	For receiving Office use only	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.92 (updated 01.01.2003)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Australian Patent Office (RO/AU)
0-7	Applicant's or agent's file reference	FP17710
I	Title of invention	THERAPEUTIC METHOD
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	PROMICS PTY LIMITED
II-5	Address:	BUILDING 64 PHYSIOLOGY & PHARMACOLOGY DEPT UNIVERSITY OF QUEENSLAND ST LUCIA, Queensland 4072 Australia
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III-1-7	State of residence	AU

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III-2	Applicant and/or inventor	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	SHIELDS, Ian, Alexander
III-2-5	Address:	17 SHERLOCK ROAD MUIRLEA ROAD MUIRLEA, Queensland 4306 Australia
III-2-6	State of nationality	AU
III-2-7	State of residence	AU
III-3	Applicant and/or inventor	
III-3-1	This person is:	applicant and inventor
III-3-2	Applicant for	US only
III-3-4	Name (LAST, First)	BROWN, Lindsay, Charles
III-3-5	Address:	31 GLEN ROSS ROAD SINNAMON PARK, Queensland 4073 Australia
III-3-6	State of nationality	AU
III-3-7	State of residence	AU
IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
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IV-1-5	e-mail	ghmelb@griffithhack.com.au

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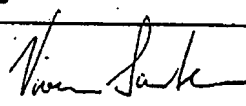
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	<p>AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZM ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT</p> <p>EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT</p> <p>EP: AT BE BG CH&amp;LI CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL PT SE SI SK TR and any other State which is a Contracting State of the European Patent Convention and of the PCT</p> <p>OA: BF BJ CF CG CI CM GA GN GQ GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT</p>
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	<p>AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH&amp;LI CN CO CR CU CZ DE DK DM DZ EC EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NI NO NZ OM PH PL PT RO RU SC SD SE SG SK SL TJ TM TN TR TT TZ UA UG US UZ VC VN YU ZA ZM ZW</p>
V-5	Precautionary Designation Statement  In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	08 April 2002 (08.04.2002)
VI-1-2	Number	PS1606
VI-1-3	Country	AU

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FP177.10

VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Australian Patent Office (ISA/AU)	
VII-2	Request to use results of earlier search; reference to that search		
VII-2-1	Date	23 April 2002 (23.04.2002)	
VII-2-2	Number	02/1141	
VII-2-3	Country (or regional Office)	AU	
VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	Check list	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	5	-
IX-2	Description	37	-
IX-3	Claims	4	-
IX-4	Abstract	1	EZABST00.TXT
IX-5	Drawings	16	-
IX-7	TOTAL	63	
	Accompanying items	paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-17	PCT-EASY diskette	-	Diskette
IX-19	Figure of the drawings which should accompany the abstract	5a	
IX-20	Language of filing of the International application	English	
X-1	Signature of applicant, agent or common representative		
X-1-1	Name	GRIFFITH HACK	
X-1-2	Name of signatory	Dr Vivien Santer	
X-1-3	Capacity	Patent Attorney	

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X-2	Signature of applicant, agent or common representative	<i>Alan Scott</i>
X-2-1	Name	PROMICS PTY LIMITED
X-2-2	Name of signatory	Alan Scott
X-3	Signature of applicant, agent or common representative	<i>ML</i>
X-3-1	Name (LAST, First)	TAYLOR, Stephen, Maxwell
X-4	Signature of applicant, agent or common representative	<i>I Shields</i>
X-4-1	Name (LAST, First)	SHIELDS, Ian, Alexander
X-5	Signature of applicant, agent or common representative	<i>Lindsay Brown</i>
X-5-1	Name (LAST, First)	BROWN, Lindsay, Charles

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/AU
10-6	Transmittal of search copy delayed until search fee is paid	

## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference VS:CE:FP17710	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. <b>PCT/AU2003/000415</b>	International Filing Date (day/month/year) 7 April 2003	Priority Date (day/month/year) 8 April 2002
International Patent Classification (IPC) or national classification and IPC Int. Cl. <sup>7</sup> A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00		
Applicant PROMICS PTY LIMITED et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

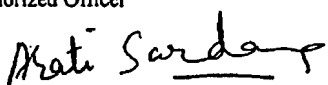
2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 9 sheet(s).

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26 September 2003	Date of completion of the report 2 July 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  ARATI SARDANA Telephone No. (02) 6283 2627

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ \_\_\_\_\_

## PCT DEMAND

## CHAPTER II

under Article 31 of the Patent Cooperation Treaty:  
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated)

For international Preliminary Examining Authority use only

Identification of IPEA

Date of receipt of DEMAND

### Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agents file reference  
VS:FP17710

International application No.  
PCT/AU03/00415

International filing date (day/month/year)  
7 April 2003

(Earliest) Priority date (day/month/year)  
8 April 2002

Title of the invention

USE OF CSA RECEPTOR ANTAGONIST IN THE TREATMENT OF FIBROSIS

### Box No. II APPLICANT(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)

PROMICS PTY LIMITED  
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PHYSIOLOGY & PHARMACOLOGY DEPT  
UNIVERSITY OF QUEENSLAND  
ST LUCIA QLD 4072

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Facsimile No.

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State (that is, country) of residence:  
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Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)

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Australia

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Australia

State (that is, country) of residence:  
Australia

☒ Further applicants are indicated on a continuation sheet.

## Continuation of Box No. II APPLICANT(S)

*If none of the following sub-boxes are used, then this sheet should not be included in the demand (renumber pages accordingly).*

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)*

BROWN, Lindsay, Charles  
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Sinnamon Park, Queensland 4073  
Australia

State *(that is, country)* of nationality:  
Australia

State *(that is, country)* of residence:  
Australia

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

☐ Further applicants are indicated on a continuation sheet.

**Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The following person is ☒ agent ☐ common representative  
 and ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.  
☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked  
☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation.  
 The address must include postal code and name of country)*

Dr Vivien Santer  
 Griffith Hack  
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 MELBOURNE VIC 3004

Telephone No.

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Facsimile No.

+61 3 9243 8333

Teleprinter No.

☐ Address for correspondence: Mark this checkbox where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments\***

1. The applicant wishes the international preliminary examination to start on the basis of:
  - ☒ The international application as originally filed
  - the description ☐ as originally filed  
☐ as amended under Article 34
  - the claims ☐ as originally filed  
☐ as amended under Article 19 (together with any accompanying statement)  
☐ as amended under Article 34
  - the drawings ☐ as originally filed  
☐ as amended under Article 34
2. ☐ The applicant wishes any amendment to the claim under Article 19 to be considered reversed.
3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This checkbox may be marked only where the limit under Article 19 has not yet expired).*

\* Where no checkbox is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purpose of international preliminary examination: ENGLISH

- ☒ which is the language in which the international application is filed  
☐ which is the language of a translation furnished for the purposes in international search  
☐ which is the language of publication of the international application  
☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

**Box No. V ELECTION OF STATES**

The applicant hereby elects all eligible states (that is, all states which have been designated and which are bound by chapter II of the PCT)  
 Excluding the following states which the applicant does not wish to elect:

## Box no. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- |  |              |
|--|--------------|
| 1. translation of international application:                             | _____ sheets |
| 2. amendments under Article 34:  | _____ sheets |
| 3. copy (or where required, translation) of amendments under Article 19: | _____ sheets |
| 4. copy (or where required, translation) of statement under Article 19:  | _____ sheets |
| 5. letter:   | _____ sheets |
| 6. other (specify):  | _____ sheets |

For International Preliminary  
Examining Authority use only

received \_\_\_\_\_ not received \_\_\_\_\_

The demand is accompanied by the item(s) marked below:

- |  |   |
|--|---|
| 1. <input type="checkbox"/> fee calculation sheet  | 4. <input type="checkbox"/> statement explaining lack of signature                                  |
| 2. <input type="checkbox"/> separate signed power of attorney                            | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (specify):  |

## Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand)

Signature \_\_\_\_\_

26/09/03  
Date

Dr Vivien Santer of Griffith Hack for and behalf of the applicant(s)

For International Preliminary Examining Authority use only

- |  |  |
|--|--|
| 1. Date of actual receipt of DEMAND:   |  |
| 2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):   |  |
| 3. <input type="checkbox"/> The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply                         | <input type="checkbox"/> The applicant has been informed accordingly |
| 4. <input type="checkbox"/> The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of rule 80.5                                |  |
| 5. <input type="checkbox"/> Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82. |  |

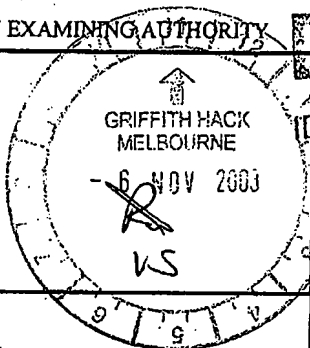
Demand received from IPEA on:

For International Bureau use only

# PATENT COOPERATION TREATY

From the:  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:  
  
Griffith Hack  
GPO Box 1285K  
MELBOURNE VIC 3001



**PCT**

**WRITTEN OPINION**  
(PCT Rule 66)

Applicant's or agent's file reference <b>VS:CE:FP17710</b>		Date of mailing (day/month/year) <b>03 NOV 2003</b>
International Application No. <b>PCT/AU03/00415</b>		REPLY DUE within <b>TWO MONTHS</b> from the above date of mailing
International Filing Date (day/month/year) <b>7 April 2003</b>	Priority Date (day/month/year) <b>8 April 2002</b>	
International Patent Classification (IPC) or both national classification and IPC <b>Int. Cl. <sup>7</sup> A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00</b>		
Applicant <b>PROMICS PTY LIMITED et al</b>		

1. This written opinion is the **first** drawn by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
 

I	<input checked="" type="checkbox"/>	Basis of the opinion
II	<input type="checkbox"/>	Priority
III	<input type="checkbox"/>	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input type="checkbox"/>	Lack of unity of invention
V	<input checked="" type="checkbox"/>	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input type="checkbox"/>	Certain documents cited
VII	<input type="checkbox"/>	Certain defects in the international application
VIII	<input type="checkbox"/>	Certain observations on the international application
3. The **FINAL DATE** by which the international preliminary examination report must be established according to Rule 69.2 is:  
**8 August 2004**
4. The applicant is hereby invited to reply to this opinion.
 

<b>When?</b>	See the Reply Due date indicated above. However, the Australian Patent Office will not establish the Report before the earlier of (i) a response being filed, or (ii) one month before the Final Date by which the international preliminary examination report must be established. The Report will take into account any response (including amendments) filed before the Report is established. If no response is filed by 1 month before the Final Date, the international preliminary examination report will be established on the basis of this opinion. Applicants wishing to have the benefit of a further opinion (if needed) before the report is established should ensure that a response is filed at least 3 months before the Final Date by which the international preliminary examination report must be established.
<b>How?</b>	By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.
<b>Also</b>	For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4bis. For an informal communication with the examiner, see Rule 66.6.

Name and mailing address of the IPEA/AU  
AUSTRALIAN PATENT OFFICE  
PO BOX 200, WODEN ACT 2606, AUSTRALIA  
E-mail address: pct@ipaustalia.gov.au  
Facsimile No. (02) 6285 3929

Authorized Officer

*Arati Sardana*  
**ARATI SARDANA**

Telephone No. (02) 6283 2627

# WRITTEN OPINION

International application No.  
PCT/AU03/00415

## I. Basis of the opinion

### 1. With regard to the elements of the international application:\*

- ☒ the international application as originally filed.
- ☐ the description, pages , as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the claims, pages , as originally filed,  
pages , as amended under Article 19,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the drawings, pages , as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of

### 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

### 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

### 4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

### 5. ☐ This opinion has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"

**WRITTEN OPINION**

International application No.

**PCT/AU03/00415**

**V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Claims	YES
	Claims 1-13	NO
Inventive step (IS)	Claims	YES
	Claims 1-13	NO
Industrial applicability (IA)	Claims 1-13	YES
	Claims	NO

**2. Citations and explanations**

**CITATIONS:**

**D1: US 4,692,511 A**

**D2: AU 80926/98 A**

**D3: WO 02/14265 A**

**EXPLANATION:**

**NOVELTY (N) Claims 1-13**

Claims 1-4, 8 and 13 are not novel in light of the disclosure of D1 which discloses treating fibrotic conditions by administering C5a receptor antagonist.

Claims 1-13 are not novel in light of the disclosure of D2 which discloses treating fibrotic conditions by administering C5a receptor antagonist of formula I.

Claims 1-4, 8 and 13 are not novel in light of the disclosure of D3. which discloses treating fibrotic conditions by administering C5a receptor antagonist.

**INVENTIVE STEP (IS) Claims 1-13**

Claims 1-13 are not novel and therefore not inventive.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
23 October 2003 (23.10.2003)

PCT

(10) International Publication Number  
**WO 03/086448 A1**

(51) International Patent Classification<sup>7</sup>: **A61K 38/04**,  
39/395, 38/08, A61P 13/12, 9/10, 11/00

[AU/AU]; 31 Glen Ross Road, Sinnamon Park, Queens-  
land 4073 (AU).

(21) International Application Number: PCT/AU03/00415

(74) Agent: **GRIFFITH HACK**; 509 St Kilda Road, Mel-  
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(22) International Filing Date: 7 April 2003 (07.04.2003)

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD,  
SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US,  
UZ, VC, VN, YU, ZA, ZM, ZW.

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
PS 1606 8 April 2002 (08.04.2002) AU

(71) Applicant (*for all designated States except US*):  
**PROMICS PTY LIMITED** [AU/AU]; BUILDING  
64, PHYSIOLOGY & PHARMACOLOGY DEPT, UNI-  
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4072 (AU).

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,  
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,  
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors; and

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Queensland 4306 (AU). **BROWN, Lindsay, Charles**

Published:

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.*

(54) Title: USE OF C5A RECEPTOR ANTAGONIST IN THE TREATMENT OF FIBROSIS

(57) Abstract: This invention relates to the use of an antagonist of a G protein-coupled receptor in the prevention and/or treatment of fibrosis, such as the treatment of fibrosis associated with myocardial infarction or diabetes or certain pulmonary conditions. In a preferred embodiment the antagonist is a C5a receptor antagonist, more preferably a cyclic peptide antagonist of the C5a receptor. In particular the invention provides a method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.



WO 03/086448 A1

Use of C5a receptor antagonist  
in the treatment of fibrosis

FIELD OF THE INVENTION

5           This invention relates to the use of an antagonist  
of a G protein-coupled receptor in the prevention and/or  
treatment of fibrosis, such as the treatment of fibrosis  
associated with myocardial infarction, diabetes, or certain  
pulmonary conditions. In a preferred embodiment the  
10 antagonist is a C5a receptor antagonist, more preferably a  
cyclic peptide antagonist of the C5a receptor.

BACKGROUND OF THE INVENTION

15           All references, including any patents or patent  
applications, cited in this specification are hereby  
incorporated by reference. No admission is made that any  
reference constitutes prior art. The discussion of the  
references states what their authors assert, and the  
applicants reserve the right to challenge the accuracy and  
20 pertinency of the cited documents. It will be clearly  
understood that, although a number of prior art  
publications are referred to herein, this reference does  
not constitute an admission that any of these documents  
forms part of the common general knowledge in the art, in  
25 Australia or in any other country.

          G protein-coupled receptors are prevalent  
throughout the human body, comprising approximately 60% of  
known cellular receptor types. They mediate signal  
transduction across the cell membrane for a very wide range  
30 of endogenous ligands and consequently participate in a  
diverse array of physiological and pathophysiological  
processes, including, but not limited to, those associated  
with cardiovascular, central and peripheral nervous system  
reproductive, metabolic, digestive, immunoinflammatory, and  
35 growth disorders, as well as other cell regulatory and  
proliferative disorders. Agents which selectively modulate

functions of G protein-coupled receptors have the potential for therapeutic applications. These receptors are becoming increasingly recognised as important drug targets, due to their crucial roles in signal transduction (G protein-coupled receptors, IBC Biomedical Library Series, 1996)

One of the most intensively studied G protein-coupled receptors is the receptor for C5a. C5a is one of the most potent chemotactic agents known, recruiting neutrophils and macrophages to sites of injury, altering their morphology; inducing degranulation; increasing calcium mobilisation, vascular permeability (oedema) and neutrophil adhesiveness; contracting smooth muscle; stimulating the release of inflammatory mediators, including histamine, TNF- $\alpha$ , IL-1, IL-6, IL-8, prostaglandins, and leukotrienes, and of lysosomal enzymes; promoting the formation of oxygen radicals; and enhancing antibody production (Gerard and Gerard, 1994).

Overexpression or underregulation of C5a is implicated in the pathogenesis of immune system-mediated inflammatory conditions, such as rheumatoid arthritis, adult respiratory distress syndrome (ARDS), systemic lupus erythematosus, tissue graft rejection, ischaemic heart disease, reperfusion injury, septic shock, psoriasis, gingivitis, atherosclerosis, Alzheimer's disease, lung injury and extracorporeal post-dialysis syndrome, and in a variety of other conditions (Whaley 1987; Sim 1993).

Agents which limit the pro-inflammatory actions of C5a have potential for inhibiting chronic inflammation, and its accompanying pain and tissue damage. For these reasons, molecules which prevent C5a from binding to its receptors are useful for treating chronic inflammatory disorders driven by complement activation. Such compounds also provide valuable new insights into the mechanisms of complement-mediated immunity.

In our previous applications No. PCT/AU98/00490 and Australian provisional No. PR8334, the entire

disclosures of which are incorporated herein by this reference, we described the three-dimensional structure of some analogues of the C-terminus of human C5a, and used this information to design novel compounds which bind to the human C5a receptor (C5aR), behaving as either agonists or antagonists of C5a. It had previously been thought that a putative antagonist might require both a C-terminal arginine and a C-terminal carboxylate for receptor binding and antagonist activity (Kontzatis et al, 1994). In PCT/AU98/00490 we showed that in fact a terminal carboxylate group is not generally required either for high affinity binding to C5aR or for antagonist activity. Instead we found that a hitherto unrecognised structural feature, a turn conformation, was the key recognition feature for high affinity binding to the human C5a receptor on neutrophils. As described in our Australian provisional application No. PR8334, filed on 17<sup>th</sup> October 2001, we used these findings to design constrained structural templates which enable hydrophobic groups to be assembled into a hydrophobic array for interaction with a C5a receptor. We have subsequently found that preferred compounds of this class are able to inhibit inflammatory bowel disease, osteoarthritis, and hypersensitivity states, and this is described in our Australian provisional applications No. 2002952084, filed on 16<sup>th</sup> October 2002, No. 2002952086, filed on 16<sup>th</sup> October 2002, and No. 2002952129, filed on 17<sup>th</sup> October 2002 respectively. The entire disclosures of these specifications are incorporated herein by this reference.

Fibrosis, the ingrowth of fibroblasts and the production of extracellular matrix to form abnormal scarring, can result from many causes, including trauma, surgical interventions, infections and pathological conditions. Fibrosis is a sequel of conditions such as chronic inflammation, including inflammation arising from diabetes and hypertension, but can arise in the absence of inflammation. It can occur in a variety of tissues,

including but not limited to the lung, kidney, liver and heart. Fibrosis contributes to the loss of function experienced in such conditions, through the formation of abnormal quantities of extracellular matrix which change the physical properties of the scarred tissue. Diabetes- or hypertension-induced fibrosis of the heart, for instance, produces stiffening of the ventricle walls which contributes to decreased cardiac output.

It is estimated that 45% percent of deaths in the USA are attributable to disorders exhibiting proliferative fibrosis. Although fibrosis is debilitating and may be life-threatening, and the number of individuals who may benefit from an effective antifibrotic therapy is large, currently there are no effective treatments available.

Both acute and chronic diseases which induce inflammation in the lung can lead to an irreversible process characterized by pulmonary fibrosis (PF). Pulmonary fibrosis may also occur as a side-effect of treatment with chemotherapeutic agents such as bleomycin. Pulmonary fibrosis is a severe disease, which leads to functional impairment and death. Cardiac fibrosis is associated with chronic hypertension, and both cardiac and renal fibrosis are long-term sequelae of diabetes.

Fibrosis is a dynamic process, and is considered to be potentially reversible. The extracellular matrix laid down during fibrosis may be resorbed after the withdrawal of the fibrotic stimuli. In many cases, however, the presence of fibrosis is only identified after loss of function has already taken place, for instance where decreased cardiac output is a sign of otherwise undetected cardiac fibrosis. Consequently, while it is desirable in certain circumstances to be able to prevent fibrosis from occurring, it is also desirable to be able to reverse existing fibrosis once it is detected. However, current therapeutic options for the treatment of fibrotic conditions are limited and relatively ineffective (el-Nahas

et al. 1997).

The effects of drug-induced and hypertension-induced pulmonary and renal fibrosis in animal models can be prevented or partially reversed by compounds which act by suppressing inflammatory events and down-regulating lung pro-collagen I over-expression (Iyer et al., 1999a,b).

We have shown that the administration of pirfenidone or spironolactone can prevent and partially reverse cardiac fibrosis and the increase in cardiac stiffness which occurs in streptozotocin-induced diabetes in rats (Miric G, et al., 2001). It is thought that pirfenidone acts by inhibiting increased TGF- $\beta$  mRNA expression, allowing an increase in expression of metalloproteases which degrade the collagen I laid down during fibrosis. The mode of action of spironolactone is at present unknown. Spironolactone is a steroid analogue which is primarily used as a diuretic; pirfenidone (5-methyl-1-phenyl-2-(1H)-pyridone), an investigational compound being investigated as an anti-fibrotic agent in a number of indications.

It would be highly desirable to identify other therapeutically or prophylactically active agents for use in the treatment or prevention of fibrosis.

The overexpression or underregulation of a G-protein-coupled receptor, the C5a receptor, has been implicated in immune-system mediated events such as inflammation. Agents which influence C5a receptor activity, such as C5a receptor antagonists, have the potential to mediate inflammatory events, and may provide a means of therapeutic or prophylactic intervention, but have not previously been suggested as potential agents in the treatment or prevention of fibrosis.

We have now surprisingly found that a cyclic peptide with C5a receptor antagonist has the ability to ameliorate cardiac fibrosis in an animal model of this condition.

SUMMARY OF THE INVENTION

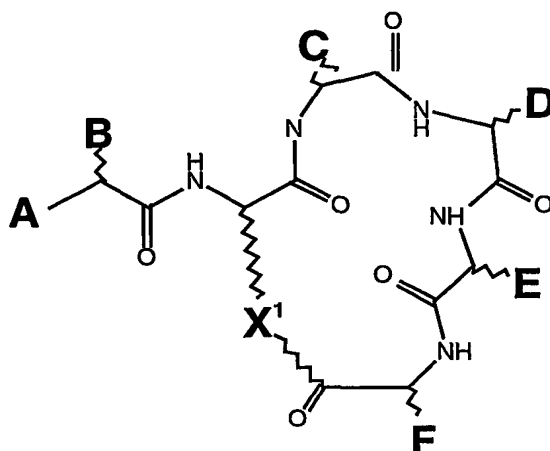
According to a first aspect, the invention provides a method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.

The use of any compound having activity as an antagonist of a G protein-coupled receptor, and particularly as a C5a receptor antagonist, is contemplated, including but not limited to those disclosed in our earlier International patent applications No. PCT/AU98/00490 or No. PCT/AU02/01427 or in International patent applications No. PCT/US00/11187 by Neurogen Corporation and No. PCT/JP01/06902 by Welfide Corporation, or antibody antagonists such as those disclosed in PCT/US00/24219 or US patent No. 6355245. The entire disclosures of all of these specifications are incorporated herein by this cross-reference.

More preferably the C5a receptor antagonist is a peptide or a peptidomimetic compound, and more preferably is a cyclic peptide or a cyclic peptidomimetic compound. Even more preferably the compound is a cyclic peptide or a cyclic peptidomimetic compound of PCT/AU98/00490 or PCT/AU02/01427.

Still more preferably the antagonist is a compound which

- (a) is an antagonist of a G protein-coupled receptor,
- (b) has substantially no agonist activity, and
- (c) is a cyclic peptide or peptidomimetic compound of formula I



5               where A is H, alkyl, aryl, NH<sub>2</sub>, NH-alkyl, N(alkyl)<sub>2</sub>, NH-aryl, NH-acyl, NH-benzoyl, NHSO<sub>3</sub>, NHSO<sub>2</sub>-alkyl, NHSO<sub>2</sub>-aryl, OH, O-alkyl, or O-aryl;

              B is an alkyl, aryl, phenyl, benzyl, naphthyl or indole group, or the side chain of a D- or L-amino acid  
10   such as L-phenylalanine or L-phenylglycine, but is not the side chain of glycine, D-phenylalanine, L-homophenylalanine, L-tryptophan, L-homotryptophan, L-tyrosine, or L-homotyrosine;

              C is a small substituent, such as the side chain  
15   of a D-, L- or homo-amino acid such as glycine, alanine, leucine, valine, proline, hydroxyproline, or thioproline, but is preferably not a bulky substituent such as isoleucine, phenylalanine, or cyclohexylalanine;

              D is the side chain of a neutral D-amino acid such  
20   as D-Leucine, D-homoleucine, D-cyclohexylalanine, D-homocyclohexylalanine, D-valine, D-norleucine, D-homo-norleucine, D-phenylalanine, D-tetrahydroisoquinoline, D-glutamine, D-glutamate, or D-tyrosine, but is preferably not a small substituent such as the side chain of glycine  
25   or D-alanine, a bulky planar side chain such as D-tryptophan, or a bulky charged side chain such as D-arginine or D-Lysine;

E is a bulky substituent, such as the side chain of an amino acid selected from the group consisting of L-phenylalanine, L-tryptophan and L-homotryptophan, or is L-1-naphthyl or L-3-benzothienyl alanine, but is not the side chain of D-tryptophan, L-N-methyltryptophan, L-homophenylalanine, L-2-naphthyl L-tetrahydroisoquinoline, L-cyclohexylalanine, D-leucine, L-fluorenylalanine, or L-histidine;

F is the side chain of L-arginine, L-homoarginine, L-citrulline, or L-canavanine, or a bioisostere thereof, ie. a side chain in which the terminal guanidine or urea group is retained, but the carbon backbone is replaced by a group which has different structure but is such that the side chain as a whole reacts with the target protein in the same way as the parent group; and

X is  $-(CH_2)_nNH-$  or  $(CH_2)_nS-$ , where n is an integer of from 1 to 4, preferably 2 or 3;  $-(CH_2)_2O-$ ;  $-(CH_2)_3O-$ ;  $-(CH_2)_3-$ ;  $-(CH_2)_4-$ ;  $-CH_2COCHRNH-$ ; or  $-CH_2-CHCOCHRNH-$ , where R is the side chain of any common or uncommon amino acid.

In C, both the *cis* and *trans* forms of hydroxyproline and thioproline may be used.

Preferably A is an acetamide group, an aminomethyl group, or a substituted or unsubstituted sulphonamide group.

Preferably where A is a substituted sulphonamide, the substituent is an alkyl chain of 1 to 6, preferably 1 to 4 carbon atoms, or a phenyl or toluyll group.

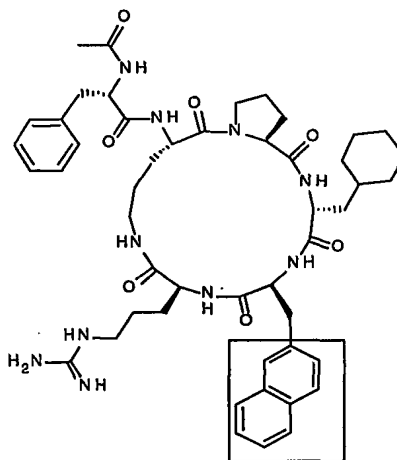
Preferably the antagonist is a C5a receptor antagonist. In a particularly preferred embodiment, the compound has antagonist activity against C5aR, and has no C5a agonist activity.

The compound is preferably an antagonist of C5a receptors on human and mammalian cells including, but not limited to, human polymorphonuclear leukocytes and human macrophages. The compound preferably binds potently and

selectively to C5a receptors, and morepreferably has  
potent antagonist activity at sub-micromolar  
concentrations. Even more preferably the compound has a  
receptor affinity  $IC_{50} < 25 \mu M$ , and an antagonist potency  
5  $IC_{50} < 1 \mu M$ .

In particularly preferred embodiments the compound  
is selected from the group consisting of compounds 1 to 6,  
10 to 15, 17, 19, 20, 22, 25, 26, 28, 30, 31, 33 to 37, 39  
to 45, 47 to 50, 52 to 58 and 60 to 70 described in  
10 International patent application No. PCT/AU02/01427. In a  
particularly preferred embodiment, the compound is PMX53  
(compound 1), compound 33, compound 60 or compound 45  
described therein.

Most preferably the compound is the compound  
15 designated PMX53, disclosed in PCT/AU98/00490, which has  
the formula



In a second aspect, the invention provides the use  
of a C5a receptor antagonist for the manufacture of a  
medicament for use in the treatment of a fibrotic  
condition.

For the purposes of this specification, the term  
35 "C5a receptor antagonist" includes any compound which can  
reduce or inhibit effects mediated by the interaction

between C5a and C5a<sub>1</sub> receptor. Thus the term includes polyclonal or monoclonal antibodies, peptides, peptidomimetics, and non-peptide compounds.

Methods and pharmaceutical carriers for preparation of suitable formulations for administration by any desired route may be prepared by standard methods, for example by reference to well-known textbooks such as Remington: The Science and Practice of Pharmacy, Vol. II, 1995 (19<sup>th</sup> edition), A.R. Gennaro (ed), Mack Publishing Company, Easton, Pennsylvania, or Australian Prescription Products Guide, Vol. 1, 1995 (24<sup>th</sup> edition) J. Thomas (ed), Australian Pharmaceutical Publishing Company Ltd, Victoria, Australia.

The compounds may be administered at any suitable dose and by any suitable route. Oral, transdermal or intranasal administration is preferred, because of the greater convenience and acceptability of these routes. The effective dose will depend on the nature of the condition to be treated, and the age, weight, and underlying state of health of the individual being treated. This will be at the discretion of the attending physician or veterinarian. Suitable dosage levels may readily be determined by trial and error experimentation, using methods which are well known in the art.

The carrier or diluent, and other excipients, will depend on the route of administration, and again the person skilled in the art will readily be able to determine the most suitable formulation for each particular case.

While it is particularly contemplated that the subject for treatment by the method of the invention is human, the treatment is also applicable to veterinary treatment, including treatment of companion animals such as dogs and cats, and domestic animals such as horses, cattle and sheep, or zoo animals such as felids, canids, bovids, and ungulates.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1a shows a comparison of the daily water intake for control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM. The arrow indicates initiation of L-NAME treatment.

Figure 1b shows a comparison of the daily L-NAME intake for L-NAME and L-NAME+C5a receptor antagonist treated rats.

Figure 2 shows a comparison of the body weight of control rats and rats treated with control agent + C5a antagonist, L-NAME and L-NAME+C5a antagonist. Values are expressed as mean  $\pm$  SEM. The arrow indicates initiation of L-NAME treatment.

Figure 3 shows a comparison of systolic blood pressure measurements of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats at day 32. Values expressed as mean  $\pm$  SEM. \* $p < 0.05$  compared to control. \*\* $p < 0.05$  compared to L-NAME.

Figure 4 shows a comparison of the left ventricular wet weight of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values expressed as mean  $\pm$  SEM. \* $p < 0.05$  compared to control.

Figure 5 shows a comparison of the interstitial collagen deposition in the left ventricle of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM. \* $p < 0.05$  compared to control; \*\*  $p < 0.05$  compared to L-NAME.

- (a) interstitial
- (b) perivascular

Figure 6a shows a comparison of interstitial collagen deposition in the heart ventricles of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM. \* $p < 0.05$  compared to control; \*\*  $p < 0.05$  compared to L-NAME.

- (a) left vent ricle
- (b) right ven tricle

Figure 7 shows a comparison of collagen deposition in the kidneys of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM. \*p <0.05 compared to control; \*\* p <0.05 compared to L-NAME.

- (a) tubulointerstitial
- (b) glomerular

Figure 8 shows a comparison of inflammatory cell count in the heart ventricles of control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM. \*p <0.05 compared to control; \*\* p <0.05 compared to L-NAME.

- (a) left ventricle
- (b) right ventricle

Figure 9 summarizes echocardiographic data for control, control+C5a antagonist, L-NAME and L-NAME+C5a receptor antagonist treated rats. \*p<0.05 compared to control; \*\*p<0.05 compared to L-NAME.

- a. Left ventricular wall thickness in diastole.
- b. Left ventricular internal diameter in diastole.
- c. E/A flow ratio.
- d. Diastolic volume.
- e. Cardiac output.

Figure 10 shows a comparison of diastolic stiffness constants for control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values expressed as mean  $\pm$  SEM. \*p <0.05 compared to control; \*\*p<0.05 compared to L-NAME.

Figure 11 shows a comparison of developed pressure for control, control+C5a antagonist, L-NAME and L-NAME+C5a antagonist treated rats. Values are expressed as mean  $\pm$  SEM.

Figure 12 shows haematoxylin and eosin-stained sections of rat lung at x40 magnification.

a) Normal lung.

b) Lung 7-9 days after intra-tracheal bleomycin instillation, showing severe patchy lesions around the airways. There was no significant difference  
5 between PMX53-treated rats and non-treated rats (n=4 in each group).

Figure 13a shows a higher magnification view of a patchy lesion (x200) showing inflammatory cells in the alveolar space and alveolar septa, with leakage of red  
10 cells and plasma. Figure 13b shows a higher magnification view of normal lung (x200), showing the two types of alveolar epithelial cells (AECs): type I AECs (40%) are flat cells, and form 90% of the surface lining of the alveolar sacs and alveoli (double arrows). Type II AECs  
15 (60%) are rounded cells which are commonly located in obtuse angles in the polygonal alveolus (arrows) rather than the surface region. When the alveolar epithelium is exposed to certain toxic agents, particularly if there is extensive destruction of the sensitive type I AECs, type II  
20 AECs increase in size and number.

Figure 14 shows the increased size and number of Type II alveolar epithelial cells in lungs of bleomycin-treated rats (arrows) (x200).

Figure 15 shows the effect of PMX53 on  
25 bleomycin-induced collagen deposition in acute lung inflammation (7-9 days).

Figure 16 shows lung tissue from a bleomycin-instilled, PMX53-treated rat 18 days after instillation, illustrating the decrease in size of patchy lesions around  
30 the airways compared to the acute inflammatory stage illustrated in Figure 12b (x40).

Figure 17 shows a higher magnification view (x200) of lung tissue from a non-drug treated bleomycin-instilled rat.

35 a) Alveolar macrophages (arrows) in the alveolar space.

b) Increase in alveolar wall thickness, with some collagen deposition (arrow) in the alveolar septa.

Figure 18 shows collagen as detected by Picro Sirius Red staining in rat lung (x40).

5 a) Normal rat.

b) Non-treated bleomycin instilled rat, showing increased collagen in thickened alveolar wall.

c) Non-drug treated bleomycin instilled rat, showing typical fibrous foci in the alveolar space.

10 Figure 19 shows the effect of PMX53 on bleomycin-induced collagen deposition in rat lung at 18 days after bleomycin instillation.

#### DETAILED DESCRIPTION OF THE INVENTION

15

For the purposes of this specification, the term "fibrotic condition" is to be taken to mean any fibrotic disorder, such as multiple sclerosis, retinal disorders including proliferative vitreoretinopathy and macular  
20 degeneration, scleroderma, sclerosing peritonitis, fibrosis arising from trauma, burns, chemotherapy, radiation, infection or surgery and fibrosis of major organs such as the kidney, liver, heart or lungs.

25 The term "C5a receptor antagonist" includes any compound which can reduce or inhibit effects mediated by the interaction between C5a and C5a receptor. Thus the term includes polyclonal or monoclonal antibodies, peptides, peptidomimetics, and non-peptide compounds.

30 The terms "treating," "treatment," and "therapy" as used herein refer to curative therapy, prophylactic therapy, and preventative therapy.

For the purposes of this specification it will be clearly understood that the word "comprising" means "including but not limited to", and that the word  
35 "comprises" has a corresponding meaning.

As used herein, the singular forms "a", "an", and

"the" include plural reference unless the context clearly dictates otherwise. Thus, for example a reference to "an enzyme" includes a plurality of such enzymes, and a reference to "an amino acid" is a reference to one or more amino acids.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any materials and methods similar or equivalent to those described herein can be used to practice or test the present invention, the preferred materials and methods are now described.

For the purposes of this specification, the term "alkyl" is to be taken to mean a straight, branched, or cyclic, substituted or unsubstituted alkyl chain of 1 to 6, preferably 1 to 4 carbons. Most preferably the alkyl group is a methyl group. The term "acyl" is to be taken to mean a substituted or unsubstituted acyl of 1 to 6, preferably 1 to 4 carbon atoms. Most preferably the acyl group is acetyl. The term "aryl" is to be understood to mean a substituted or unsubstituted homocyclic or heterocyclic aryl group, in which the ring preferably has 5 or 6 members.

A "common" amino acid is a L-amino acid selected from the group consisting of glycine, leucine, isoleucine, valine, alanine, phenylalanine, tyrosine, tryptophan, aspartate, asparagine, glutamate, glutamine, cysteine, methionine, arginine, lysine, proline, serine, threonine and histidine.

An "uncommon" amino acid includes, but is not restricted to, D-amino acids, homo-amino acids, N-alkyl amino acids, dehydroamino acids, aromatic amino acids other than phenylalanine, tyrosine and tryptophan, ortho-, meta- or para-aminobenzoic acid, ornithine, citrulline, canavanine, norleucine,  $\gamma$ -glutamic acid, aminobutyric acid,

L-fluorenylalanine, L-3-benzothienylalanine, and  $\alpha,\alpha$ -disubstituted amino acids.

Generally, the terms "treating", "treatment" and the like are used herein to mean affecting a subject, tissue or cell to obtain a desired pharmacological and/or physiological effect. The effect may be prophylactic in terms of completely or partially preventing a disease or sign or symptom thereof, and/or may be therapeutic in terms of a partial or complete cure of a disease.

"Treating" as used herein covers any treatment of, or prevention of disease in a vertebrate, a mammal, particularly a human, and includes: preventing the disease from occurring in a subject who may be predisposed to the disease, but has not yet been diagnosed as having it; inhibiting the disease, ie., arresting its development; or relieving or ameliorating the effects of the disease, ie., cause regression of the effects of the disease.

The invention includes the use of various pharmaceutical compositions useful for ameliorating disease. The pharmaceutical compositions according to one embodiment of the invention are prepared by bringing a compound of formula I, analogue, derivatives or salts thereof and one or more pharmaceutically-active agents or combinations of compound of formula I and one or more pharmaceutically-active agents into a form suitable for administration to a subject using carriers, excipients and additives or auxiliaries.

Frequently used carriers or auxiliaries include magnesium carbonate, titanium dioxide, lactose, mannitol and other sugars, talc, milk protein, gelatin, starch, vitamins, cellulose and its derivatives, animal and vegetable oils, polyethylene glycols and solvents, such as sterile water, alcohols, glycerol and polyhydric alcohols. Intravenous vehicles include fluid and nutrient replenishers. Preservatives include antimicrobial, anti-oxidants, chelating agents and inert gases. Other

pharmaceutically acceptable carriers include aqueous solutions, non-toxic excipients, including salts, preservatives, buffers and the like, as described, for instance, in Remington's Pharmaceutical Sciences, 20th ed.

5 Williams & Wilkins (2000) and The British National Formulary 43rd ed. (British Medical Association and Royal Pharmaceutical Society of Great Britain, 2002; <http://bnf.rhn.net>), the contents of which are hereby incorporated by reference. The pH and exact concentration  
10 of the various components of the pharmaceutical composition are adjusted according to routine skills in the art. See Goodman and Gilman's The Pharmacological Basis for Therapeutics (7th ed., 1985).

The pharmaceutical compositions are preferably  
15 prepared and administered in dosage units. Solid dosage units include tablets, capsules and suppositories. For treatment of a subject, depending on activity of the compound, manner of administration, nature and severity of the disorder, age and body weight of the subject, different  
20 daily doses can be used. Under certain circumstances, however, higher or lower daily doses may be appropriate. The administration of the daily dose can be carried out both by single administration in the form of an individual dose unit or else several smaller dose units and also by  
25 multiple administration of subdivided doses at specific intervals.

The pharmaceutical compositions according to the invention may be administered locally or systemically in a therapeutically effective dose. Amounts effective for this  
30 use will, of course, depend on the severity of the disease and the weight and general state of the subject. Typically, dosages used *in vitro* may provide useful guidance in the amounts useful for *in situ* administration of the pharmaceutical composition, and animal models may be  
35 used to determine effective dosages for treatment of the cytotoxic side effects. Various considerations are

described, eg. in Langer, Science, 249 1527, (1990).

Formulations for oral use may be in the form of hard gelatin capsules, in which the active ingredient is mixed with an inert solid diluent, for example, calcium

5 carbonate, calcium phosphate or kaolin. They may also be in the form of soft gelatin capsules, in which the active ingredient is mixed with water or an oil medium, such as peanut oil, liquid paraffin or olive oil.

Aqueous suspensions normally contain the active  
10 materials in admixture with excipients suitable for the manufacture of aqueous suspensions. Such excipients may be suspending agents such as sodium carboxymethyl cellulose, methyl cellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinylpyrrolidone, gum tragacanth and gum  
15 acacia; dispersing or wetting agents, which may be (a) a naturally occurring phosphatide such as lecithin; (b) a condensation product of an alkylene oxide with a fatty acid, for example, polyoxyethylene stearate; (c) a condensation product of ethylene oxide with a long chain  
20 aliphatic alcohol, for example, heptadecaethylenoxycetanol; (d) a condensation product of ethylene oxide with a partial ester derived from a fatty acid and hexitol such as polyoxyethylene sorbitol monooleate, or (e) a condensation  
25 product of ethylene oxide with a partial ester derived from fatty acids and hexitol anhydrides, for example polyoxyethylene sorbitan monooleate.

The pharmaceutical compositions may be in the form of a sterile injectable aqueous or oleaginous suspension.  
This suspension may be formulated according to known  
30 methods using suitable dispersing or wetting agents and suspending agents such as those mentioned above. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example, as  
35 a solution in 1,3-butanediol. Among the acceptable vehicles and solvents which may be employed are water,

Ringer's solution, and isotonic sodiumchloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil may be employed, including synthetic mono-or diglycerides. In addition, fatty acids such as oleic acid may be used in the preparation of injectables.

Agents useful in the invention may also be administered in the form of liposome delivery systems, such as small unilamellar vesicles, large unilamellar vesicles, and multilamellar vesicles. Liposomes can be formed from a variety of phospholipids, such as cholesterol, stearylamine, or phosphatidylcholines.

Dosage levels of the compounds of the present invention will usually be of the order of about 0.5mg to about 20mg per kilogram body weight, with a preferred dosage range between about 0.5mg to about 10mg per kilogram body weight per day (from about 0.5g to about 3g per patient per day). The amount of active ingredient which may be combined with the carrier materials to produce a single dosage will vary, depending upon the host to be treated and the particular mode of administration. For example, a formulation intended for oral administration to humans may contain about 5mg to 1g of an active compound with an appropriate and convenient amount of carrier material, which may vary from about 5 to 95 percent of the total composition. Dosage unit forms will generally contain between from about 5mg to 500mg of active ingredient.

It will be understood, however, that the specific dose level for any particular patient will depend upon a variety of factors including the activity of the specific compound employed, the age, body weight, general health, sex, diet, time of administration, route of administration, rate of excretion, drug combination and the severity of the particular disease undergoing therapy.

In addition, some of the compounds of the invention may form solvates with water or common organic solvents. Such solvates are encompassed within the scope of the invention.

5           The compounds of the invention may additionally be combined with other therapeutic compounds to provide an operative combination. It is intended to include any chemically compatible combination of pharmaceutically-active agents, as long as the combination does not  
10 eliminate the activity of the compound of this invention. For example, spironolactone, pirfenidone, *Ginkgo biloba* extract (Welt et al, 1999), and tocopherol acetate (Rosen et al, 1995) are known in the art for treatment of fibrosis. Inhibitors of prolyl hydroxylase, procollagen C-  
15 proteinase, also known as bone morphogenetic protein-1 (BMP-1), or connective tissue growth factor 02450, WO00/are being investigated for this purpose by FibroGen, Inc. See for example WO/01/56996, WO/01/15729, WO00/02450, WO00/50390, WO00/27868, WO00/13706, and WO/9921860. These  
20 compounds include prostacyclin and phenanthroline derivatives. The invention includes within its scope combinations of C5a inhibitors and such known agents.

## General Methods

25

### **Peptide synthesis**

Cyclic peptide compounds of formula I are prepared according to methods described in detail in our earlier applications No. PCT/AU98/00490 and No. PCT/AU02/01427, the  
30 entire disclosures of which are incorporated herein by this reference. While the invention is specifically illustrated with reference to the compound AcF-[OPdChaWR] (PMX53), whose corresponding linear peptide is Ac-Phe-Orn-Pro-dCha-Trp-Arg, it will be clearly understood that the invention  
35 is not limited to this compound.

Compounds 1-6, 17, 20, 28, 30, 31, 36 and 44



disclosed in International patent application  
No. PCT/AU98/00490 and compounds 10-12, 14, 15, 25, 33, 35,  
40, 45, 48, 52, 58, 60, 66, and 68-70 disclosed for the  
first time in International patent application

5 PCT/AU02/01427 have appreciable antagonist potency ( $IC_{50} < 1 \mu M$ ) against the C5a receptor on human neutrophils. PMX53 and compounds 33, 45 and 60 of PCT/AU02/01427 are most preferred.

10 We have found that all of the compounds of formula I which have so far been tested have broadly similar pharmacological activities, although the physicochemical properties, potency, and bioavailability of the individual compounds varies somewhat, depending on the specific substituents.

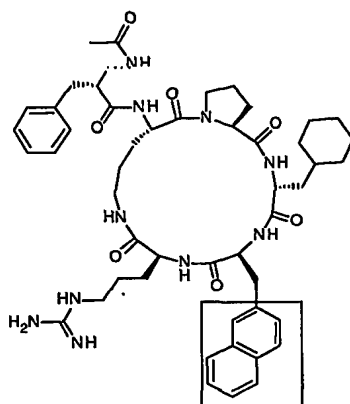
15 The general tests described in PCT/AU98/00490 and PCT/AU02/01427 may be used for initial screening of candidate inhibitor of G protein-coupled receptors, and especially of C5a receptors.

20 The invention will now be described in detail by way of reference only to the following non-limiting examples and figures.

*Example 1            Effect of a C5a receptor antagonist on L-NAME-induced cardiac fibrosis*

25

Male Wistar rats (8 weeks old) were obtained from the Central Animal Breeding House of The University of Queensland. The rats were administered a C5a receptor antagonist designated PMX53, which has the formula:



This agent was administered at a dosage of 1mg/kg/day orally for 4 days before rats were additionally treated with nitro-L-arginine methyl ester (L-NAME) for 4 weeks, ie a total duration of treatment of antagonist of 32 days. L-NAME administration produces hypertension and cardiac remodelling as a result of inhibition of the production of nitric oxide (NO).

L-NAME was administered at a concentration of 400mg/l in the drinking water for 4 weeks to give a mean daily intake of  $18.7 \pm 0.4$ mg L-NAME ( $41.4 \pm 0.8$ mg/kg mean body weight). Body weight and food and water intakes were measured daily.

Neither L-NAME nor C5a receptor antagonist treatment altered water intake or growth rate, as shown in Figures 1 and 2.

Systolic blood pressure was measured in selected unanaesthetised rats, using a tail-cuff method. As illustrated in Figure 3, systolic blood pressure increased from  $118 \pm 3$ mmHg to  $160 \pm 2$ mmHg in L-NAME-treated rats without significantly altering heart rate or increasing left ventricular weight, as determined by echocardiograph or post-mortem examination, when compared to control rats. These results are shown in Figure 4.

Similarly , right ventricular and other major organ weights were not significantly altered with L-NAME treatment.

5 C5a receptor antagonist treatment of L-NAME rats significantly increased systolic blood pressure by 16mmHg to  $176 \pm 3$ mmHg, resulting in an increased left ventricular wet weight. Additionally, C5a receptor antagonist treatment of control rats induced a non-significant increase in blood pressure. These results are summarised  
10 in Figures 3 and 4. C5a receptor antagonist treatment of both control and L-NAME rats did not significantly alter wet weights of the remaining major organs.

After 4 weeks of L-NAME treatment, heart function was determined *in vivo* by echocardiography and *in vitro*  
15 using the isolated Langendorff heart preparation described below. Collagen deposition was measured by image analysis using laser confocal microscopy of picrosirius red-stained cardiac slices, as described below.

Rats were euthanased with pentobarbitone (100  
20 mg/kg ip). Blood was taken from the abdominal vena cava, centrifuged and the plasma frozen. Plasma glucose was measured by Precision Plus Blood Glucose Electrodes (Medisense, Abbott Laboratories); plasma  $\text{Na}^+$  and  $\text{K}^+$  were measured by flame photometry.

25

a) Collagen distribution

Collagen distribution was determined by image analysis of sections of heart and kidney stained with picrosirius red (0.1% Sirius Red F3BA in picric acid),  
30 which selectively stains fibrillar collagen. Slides were left in 0.2% phosphomolybdic acid for 5 minutes, washed, and left in picrosirius red for 90 minutes, then in 1 mM HCl for 2 minutes and 70% ethanol for 45 seconds. The stained sections were analyzed with an Image Pro plus  
35 analysis program using an Olympus BH2 microscope, with results expressed as a percentage of red area in each

screen. At least 4 areas were examine in each heart. The results are present ed in Figures 5, 6 nd 7.

Image analysis showed an increase of 108% in interstitial collagen and an 87% increase in perivascular collagen in the left ventricle of L-NAME treated rats when compared to controls. Similarly, a significant increase in collagen levels was observed in the right ventricle, where a 175% increase in interstitial and a 37% increase in perivascular collagen content occurred. L-NAME treatment also significantly increased the collagen content by 55% in the tubulointerstitial areas of the kidneys with a smaller increase in glomerular spaces.

C5a receptor antagonist treatment attenuated the increased collagen deposition. In C5a antagonist treated rats, L-NAME treatment produced 23% and 43% of the increase observed in rats treated with L-NAME only when comparing the left ventricular interstitial and perivascular areas respectively. Similar results were observed in the right ventricle, where C5a receptor antagonist treatment of L-NAME restricted collagen deposition to 44 and 37% in the interstitial and perivascular areas respectively. In the kidneys, C5a antagonist administration to L-NAME rats restricted collagen deposition to 30% in the interstitium and normalized the increase in glomerular collagen concentrations observed in L-NAME treated rats.

As illustrated in Figure 9, L-NAME treatment resulted in a large inflammatory cell infiltration in both the left and right ventricles. A 30-fold increase in inflammatory cell population was observed in the both left and right ventricular interstitial and perivascular areas following L-NAME treatment. C5a receptor antagonist treatment totally prevented inflammatory cell infiltration into left or right ventricles following L-NAME treatment. No information is so far available on inflammatory cell type or kidney infiltration.

b) Echocardiographic analysis

Cardiac function was estimated *in vivo* using echocardiography, using conventional methods.

Although L-NAME treatment did not significantly increase left ventricular weight, echocardiographic M-mode measurements showed that L-NAME treatment had triggered cardiac remodelling, increasing the left ventricular wall thickness and decreasing the left ventricular internal diameter in diastole. Further L-NAME treatment significantly increased the ratio of early (E) to atrial (A) mitral valve inflow rates (E/A ratio), and significantly decreased diastolic volume and cardiac output. Fractional shortening and ascending aortic flow rates were not significantly altered by L-NAME treatment. Thus L-NAME treatment induces cardiac remodelling, with minor changes in systolic function and an improved diastolic function.

C5a receptor antagonist treatment of control rats did not significantly alter any parameter measured by echocardiographic analysis. C5a receptor antagonist treatment of L-NAME rats normalised the increase in left ventricular wall thickness and decreased left ventricular internal dimensions. This treatment also significantly normalised the E/A ratio, diastolic volume and cardiac output. These results are presented in Figure 9.

c) Isolated Langendorff heart preparation

The Langendorff isolated heart preparation was used to determine the diastolic stiffness of the left ventricles *ex vivo*.

Rats were anaesthetised with sodium pentobarbitone (100mg/kg ip) and heparin (2000 IU) was administered via the femoral vein. After allowing 2 minutes for the heparin to fully circulate, the heart was excised and placed in cooled (0°C) crystalloid perfusate (Krebs-Henseleit solution of the following composition in mM: NaCl 118, KCl 4.7, MgSO<sub>4</sub>

1.2,  $\text{KH}_2\text{PO}_4$  1.2,  $\text{CaCl}_2$  2.3,  $\text{NaHCO}_3$  25.0 glucose 11.0). The heart was then attached to the cannula with the tip of the cannula positioned immediately above the coronary ostia of the aortic stump, and perfused in a non-recirculating  
 5 Langendorff fashion at 100cm of hydrostatic pressure. The buffer temperature was maintained at 35°C. The hearts were punctured at the apex to facilitate thebesian drainage and paced at 250 bpm.

A balloon catheter was inserted in the left  
 10 ventricle via the mitral orifice for measurement of left ventricular developed pressure. The catheter was connected via a three-way tap to a micrometer syringe and to a Statham P23 pressure transducer. The outer diameter of the catheter was similar to the mitral annulus to prevent  
 15 ejection of the balloon during the systolic phase. After a 10 minute stabilisation period, steady-state left ventricular pressure was recorded from isovolumetrically beating hearts. Increments in balloon volume were applied to the heart until left ventricular end-diastolic pressure  
 20 reached approximately 30mmHg.

To assess myocardial stiffness in isolated  
 Langendorff hearts, stress ( $\sigma$ , dyne/cm<sup>2</sup>) and tangent  
 elastic modulus (E, dyne/cm<sup>2</sup>) for the midwall at the  
 equator of the left ventricle were calculated by assuming  
 25 spherical geometry of the ventricle and considering the midwall equatorial region as representative of the remaining myocardium:

$$\sigma = \frac{VP}{W} \left( 1 + \frac{4(V+W)}{[V^{1/3} + (V+W)^{1/3}]^3} \right)$$

$$E = 3 \left\{ \frac{VP}{W} - \sigma + \frac{\left[ \frac{\sigma}{V} + \frac{(W\sigma - VP)}{W(V+W)} + \frac{\sigma \cdot dP}{P \cdot dV} \right] \times [V^{1/3} + (V+W)^{1/3}]}{[V^{-2/3} + (V+W)^{-2/3}]} \right\}$$

where V is chamber volume (ml), W is left ventricular wall volume (0.943 ml/g ventricular weight) and P is end diastolic pressure (dyne/cm<sup>2</sup>=7.5x10<sup>-4</sup> mmHg). Myocardial diastolic stiffness is calculated as the diastolic stiffness constant (k, dimensionless), the slope of the linear relation between E and  $\sigma$  (Mirsky and Parmley, 1973). To assess contractile function, maximal +dP/dt was calculated at a diastolic pressure of 5 mmHg.

The results are shown in Figure 10. All results are given as mean  $\pm$  SEM of at least 6 experiments. The negative log EC50 of the increase in either force of contraction in mN or rate of contraction in beats/min was determined from the concentration giving half-maximal responses in individual concentration-response curves. Renal function results were corrected for kidney wet weight measured at the end of the experiment. These results were analysed by two-way analysis of variance followed by the Duncan test to determine differences between treatment groups and by paired or unpaired t-tests as appropriate;  $p < 0.05$  was considered significant.

At the end of the experiment, the atria and right ventricle were dissected away and the weight of the left ventricle plus septum was recorded.

L-NAME treatment markedly increased the diastolic stiffness constant of the ventricles when compared to controls. Developed pressure and contractility were not altered by L-NAME treatment. C5a receptor antagonist treatment prevented the increased diastolic stiffness constant of L-NAME rats without altering contractility or developed pressure. These results are presented in Figures 10 and 11.

d) Isolated cardiac muscles and thoracic aortic rings  
The heart is removed under anaesthesia. The right atria and papillary muscles from the left ventricle are

removed and suspended in organ baths at a resting tension of 5-10 mN adjusted to give the maxima twitch response. Tissues are bathed in a modified Tyrode's solution, containing the following concentrations of salts in mM:  
5 NaCl 136.9, KCl 5.4, MgCl<sub>2</sub> 1.05, CaCl<sub>2</sub> 1.8, NaHCO<sub>3</sub> 22.6, NaH<sub>2</sub>PO<sub>4</sub> 0.42, glucose 5.5, ascorbic acid 0.28, sodium edetate 0.05, bubbled with 95% O<sub>2</sub>/5%CO<sub>2</sub>, and stimulated at 1Hz at 35°C as previously described (Brown et al, 1991a). Cumulative concentration-response curves are measured for  
10 noradrenaline and, following washout and re-equilibration, for calcium chloride. At the end of the experiment, papillary muscle dimensions are measured under the loading conditions of the experiment; all tissues are blotted and weighed.

15 Thoracic aortic rings (approximately 4 mm in length) are suspended with a resting tension of 10 mN (Brown et al, 1991b) and contracted twice with isotonic KCl (100 mM). The presence of endothelium is demonstrated by addition of acetylcholine ( $1 \times 10^{-5}$  M). Cumulative contraction  
20 responses to noradrenaline are measured. Separate thoracic aortic rings are perfused with 10% neutral buffered formalin, embedded in wax and stained with haematoxylin and eosin. Image analysis using a Wild-Leitz MD30+ system is used to calculate the wall area of the thoracic aorta.

25  
*Example 2                      Effect Of PMX53 on Bleomycin-induced  
Pulmonary Fibrosis*

Both acute and chronic diseases which induce  
30 inflammation in the lung can lead to an irreversible process characterized by pulmonary fibrosis. The effect of PMX-53 on a rat model of pulmonary fibrosis was assessed, using methods were adapted from Taylor et al (2002).

Bleomycin is an antineoplastic agent which is a  
35 well-known cause of pulmonary fibrosis in humans (Thrall et al, 1978). Bleomycin-induced pulmonary fibrosis in rats is

a well-established model, which has a short experimental period and high success rates. Bleomycin induces toxic injury to Type I alveolar epithelial cells (AEC), which causes release of TGF- $\beta$ , PGE<sub>2</sub>, granulocyte-macrophage colony stimulating factor (GM-CSF), and insulin-like growth factors etc. This induces a massive activation of inflammatory cells such as PMNs, macrophages and mesenchymal cells such as fibroblasts, which contribute to an overaggressive repair process, leading to fibrosis in the lung. PMX53 is a C5a receptor antagonist, which effectively inhibits the infiltration and the activation of inflammatory cells, such as PMNs, monocytes, macrophages, and therefore reduces the release of reactive oxygen species and inflammatory mediators such as IL-1 and PLA<sub>2</sub>. As a result, local tissue damage is prevented by a reduction of release of several factors, such as leukotrienes, and prostaglandins. We investigated whether PMX53 antagonists had any inhibitory effect on bleomycin-induced pulmonary fibrosis.

Male Wistar rats, 6 weeks of age, were used. The rats were divided into 5 groups:

Group 1: bleomycin instillation only (n=9)

Group 2: saline instillation only (n=3)

Group 3: PMX53 at a dose rate of 10mg/kg in 200 $\mu$ l water p.o. (gavage daily) and bleomycin instillation (n=9)

Group 4: PMX53 (dose as for Group 3) p.o. and saline instillation (n=3).

Group 5: Untreated rats maintained in the same environment as the other groups (n=3).

Drug-treated rats were given drug for 3 days before bleomycin administration.

One intra-tracheal instillation of bleomycin at a dose of 0.5mg/100g (0.7U/100g) in 200 $\mu$ l of saline was performed on Day 1, as described by Taylor et al., (2002).

Rats were anaesthetized by inhalation of 5% or less halothane via a vaporizer. After a local spray of

Xylocaine to prevent airway spasm, the rats were intubated and a slow injection of bleomycin or saline control was completed. The rats were then rotated gently for about 1-2 minutes to allow the solution to diffuse evenly into both lungs (Christensen et al 2000). Rats were kept in the fume cupboard until totally recovered, and then monitored for up to 18 days. Body weight, food and water intake, and respiration were monitored daily.

Respiration was elevated as follows: Score 0, normal respiration; Score 1, increased rate of breathing; and Score 2, mouth open respiration. Rats were euthanased before the end of the experimental period, if they consistently lost more than 10% bodyweight for 48 hours, had Score 2 respiration or had Score 1 respiration for 48 hours.

At the end of this period the rats were killed by exsanguination under anaesthesia, so that the lungs were clear of blood. For each rat, the left lung was immediately frozen in liquid nitrogen and stored at  $-20^{\circ}\text{C}$  for quantitative collagen analysis using hydroxyproline assay. The right lung was fully inflated and fixed with 10% formulated formalin by airway gravity fixation at a pressure of 30 cm water for 1 minute. Haematoxylin and eosin (H&E) and Picro Sirius Red (PR) staining for collagen were performed to assess collagen deposition in the lung. For quantitation of collagen stained with PR, polarized light images were converted to grey scale, and the total number of white pixels (specific for collagen) per image was determined as a percentage of the total pixel area. The procedure was applied to a total of four fields in the alveolar area and two fields in the peribronchial area and blood vessels per sample (Wang et al, 2000). The largest lobe of the right lung (from 4 lobes) in each rat was chosen. The data was analysed using the program "Sion Image".

Hydroxyproline assay was performed by the method

of Christensen et al (2000). Lung tissue was excised, trimmed free of surrounding conducting airways, and homogenized in 2mls saline. A 1ml aliquot of lung homogenate was hydrolysed in 6N HCl (0.5ml of homogenate and 0.5ml of 12N HCl) at 110°C for 12 hours; 50µl aliquots were added to 1ml of 14% chloramine T, 10% n-propanol, and 0.5M sodium acetate, pH 6.0. After 20min at 22°C, 1ml of Ehrlich's solution (1M p-dimethylaminobenzaldehyde in 70% n-propanol and 20% perchloric acid) was added and allowed to incubate at 65°C for 15min. Absorbance was measured at 550nm, and the amount of hydroxyproline was determined against a standard curve generated with the use of known concentrations of reagent-grade hydroxyproline.

Data were compiled as the means  $\pm$  SE in the study. Tests of significance were obtained by ANOVA followed by Student-Newman-Keuls post analysis. There were two stages involved in the bleomycin-induced pulmonary fibrosis in rat model.

#### 1. Acute lung inflammation:

Intra-tracheal instillation of bleomycin induced an acute lung inflammation in the rats, evident on Day 2 - Day 3. Four of the rats from the drug-treated group and four from the non-treated group were very ill, and had to be euthanased after 7-9 days. The lungs appeared swollen, with spreading white patchy lesions, as shown in Figures 12 and 13. The lung weight to body weight ratio was significantly increased in bleomycin-treated rats, regardless of whether the rats were drug-treated or non-treated. The results are summarised in Table 1.

Table 1.

Lung weight and body weight in bleomycin-induced pulmonary fibrosis (7-9 days)

5

Condition	Left lung weight (g)	Body weight (g)	Ratio $\times 10^{-3}$
Normal	0.507 + 0.003	240.6 + 4.667	1.9 + 0.36
Bleomycin	1.004 + 0.04	226 + 8.083	4.47 + 0.46**
Bleomycin + PMX53	0.974 + 0.132	228 + 7.583	4.25 + 1.07**

\*\* :  $P < 0.001$ ,  $n=3$ , compared to normal rats.

Under the microscope, numbers of inflammatory cells, including PMNs, macrophages, lymphocytes etc. were observed in the alveolar spaces, with massive leakage of plasma and red blood cells; this is illustrated in Figure 13a. The size and number of type II AECs in the alveolar spaces was clearly increased, as shown in Figure 13b, while in normal lung, the type II AECs covered only 5 - 10% of the surface area of the alveoli, as shown in Figure 14.

There was no significant difference in histology between drug-treated and non-treated groups. Collagen deposition in bleomycin instillation lungs showed a significant increase compared to normal lungs ( $P < 0.01$ ,  $n=3$ ); saline instillation lungs ( $P < 0.01$ ,  $n=3$ ); and saline instillation with PMX53-treated lungs ( $P < 0.01$ ,  $n=3$ ). However, there was no significant difference between the drug-treated group and non-treated group ( $P > 0.01$ ,  $n=4$ ). These results are summarised in Figure 15.

25

## 2. Pulmonary fibrosis

Eighteen days after intra-tracheal instillation of bleomycin, the degree of oedema was reduced in bleomycin-instilled lungs, and the lung/body weight ratio did not

show a significant difference between either the bleomycin group and the non-bleomycin group, or between the drug-treated group and non-drug group (data not shown). As illustrated in Figure 16, the inflammatory lesions in the lung became smaller and less dense in most of the rats compared with the acute inflammatory stage, whether or not the rats had received drug treatment. There were still numbers of inflammatory cells, many of which were alveolar macrophages, and red blood cells in the lung lesions, as shown in Figure 17a. The thickness of the alveolar walls was increased, and there was some fibrinogen depositions in alveolar septa in some of the lungs, as shown in Figure 17b. One drug-treated rat and one non-drug treated rat still had some obvious lung inflammatory lesions mixed with marked lung fibrosis lesions. It was difficult to assess the quantity of collagen deposition in the lung tissues from the H&E stained slides, because the amount of collagen and the spread of the collagen varied in each individual rat, and the number of the lesions in each lung was different. PR staining was more useful than H&E staining for assessment of collagen deposition in the lungs, as illustrated in Figures 21 to 30 and as summarised in Table 2.

Table 2.

PR staining in bleomycin-induced pulmonary fibrosis (% of the total pixel area, n=3-4)

Saline	Bleomycin	Bleo+PMX53
0.01	0.01	1.43
0.04	0.21	0.06
0.007	0.78	0.01
	1.73	0.77

However, for the same reasons it was not an

accurate measurement for comparison analysis of the collagen content. The hydroxyproline assay results are summarised in Figure 19. Bleomycin instillation significantly increased hydroxyproline levels in the rat lungs ( $P < 0.01$ ,  $n=3$ , compared to normal rats;  $P < 0.01$ ,  $n=3$ , compared to saline instilled rats;  $P < 0.01$ ,  $n=3$ , compared to saline instilled with drug treated rats). PMX53 significantly reduced the bleomycin-induced hydroxyproline levels ( $P < 0.05$ ,  $n=4$ , compared to the rats with bleomycin instillation).

The failure of PMX53 to inhibit the toxic lung inflammation induced by bleomycin may indicate that the bleomycin-induced toxic inflammation was initiated through a different pathway or via a complicated inter-cellular reaction, rather than by a simple activation of the complement system. Type I AEC injury, type II AEC proliferation, fibroblast proliferation, and release of several cytokines, such as  $\text{PGE}_2$ ,  $\text{TGF-}\beta_1$ , and GM-CSF, are considered to play major roles in PF.

After 18 days, the lungs with bleomycin instillation showed some fibrosis, as demonstrated by the significantly increased hydroxyproline levels and collagen deposition as indicated by PR staining. We found that PMX53 significantly reduced the hydroxyproline levels, although this was difficult to confirm by histology or PR staining. It is possible that 18 days is too early for the histological changes to be evident, because most studies demonstrated that the DNA and hydroxyproline changes occur between 14-21 days after bleomycin instillation, while histological evidence was present after 4 weeks.

Nevertheless, the significant reduction by PMX53 of bleomycin-induced hydroxyproline deposition indicates that the activation of the C5a cascade may be involved in the progression of fibrosis, although the role of C5a in bleomycin-induced PF is not fully understood. It will be apparent to the person skilled in the art that while the

invention has been described in some detail for the purposes of clarity and understanding, various modifications and alterations to the embodiments and methods described herein may be made without departing from  
5 the scope of the inventive concept disclosed in this specification.

References cited herein are listed on the  
10 following pages, and are incorporated herein by this reference.

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**CLAIMS**

1. A method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of  
5 administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.

2. A method according to claim 1, in which the antagonist is a C5a receptor antagonist.

10 3. A method according to claim 1 or claim 2, in which the antagonist is a peptide or a peptidomimetic compound.

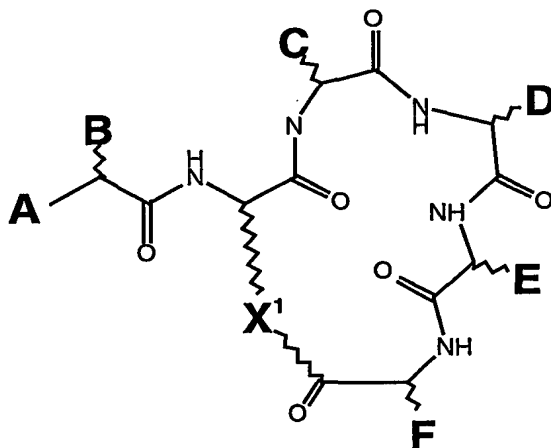
4. A method according to claim 3, in which the antagonist is a cyclic peptide or a cyclic peptidomimetic  
15 compound.

5. A method according to any one of claims 1 to 3, in which the antagonist

(a) is an antagonist of a G protein-coupled receptor,

20 (b) has substantially no agonist activity, and

(c) is a cyclic peptide or peptidomimetic compound of formula I



25

where A is H, alkyl, aryl, NH<sub>2</sub>, NH-alkyl,

N(alkyl)<sub>2</sub>, NH-aryl, NH-acyl, NH-benzoy, NHSO<sub>3</sub>, NHSO<sub>2</sub>-alkyl, NHSO<sub>2</sub>-aryl, OH, O-alkyl, or O-aryl;

B is an alkyl, aryl, phenyl, benzyl, naphthyl or indole group, or the side chain of a D- or L-amino acid such as L-phenylalanine or L-phenylglycine, but is not the side chain of glycine, D-phenylalanine, L-homophenylalanine, L-tryptophan, L-homotryptophan, L-tyrosine, or L-homotyrosine;

C is a small substituent, such as the side chain of a D-, L- or homo-amino acid such as glycine, alanine, leucine, valine, proline, hydroxyproline, or thioproline, but is preferably not a bulky substituent such as isoleucine, phenylalanine, or cyclohexylalanine;

D is the side chain of a neutral D-amino acid such as D-Leucine, D-homoleucine, D-cyclohexylalanine, D-homocyclohexylalanine, D-valine, D-norleucine, D-homonorleucine, D-phenylalanine, D-tetrahydroisoquinoline, D-glutamine, D-glutamate, or D-tyrosine, but is preferably not a small substituent such as the side chain of glycine or D-alanine, a bulky planar side chain such as D-tryptophan, or a bulky charged side chain such as D-arginine or D-Lysine;

E is a bulky substituent, such as the side chain of an amino acid selected from the group consisting of L-phenylalanine, L-tryptophan and L-homotryptophan, or is L-1-naphthyl or L-3-benzothienyl alanine, but is not the side chain of D-tryptophan, L-N-methyltryptophan, L-homophenylalanine, L-2-naphthyl L-tetrahydroisoquinoline, L-cyclohexylalanine, D-leucine, L-fluorenylalanine, or L-histidine;

F is the side chain of L-arginine, L-homoarginine, L-citrulline, or L-canavanine, or a bioisostere thereof, ie. a side chain in which the terminal guanidine or urea group is retained, but the carbon backbone is replaced by a group which has different structure but is such that the side chain as a whole reacts with the target protein in the

same way as the parent group; and

X is  $-(CH_2)_nNH-$  or  $(CH_2)_nS-$ , where n is an integer of from 1 to 4, preferably 2 or 3;  $-(CH_2)_2O-$ ;

$-(CH_2)_3O-$ ;  $-(CH_2)_3-$ ;  $-(CH_2)_4-$ ;  $-CH_2COCHRNH-$ ; or

5  $-CH_2-CHCOCHRNH-$ , where R is the side chain of any common or uncommon amino acid.

6. A method according to claim 5, in which A is an acetamide group, an aminomethyl group, or a substituted or unsubstituted sulphonamide group.

10 7. A method according to claim 6, in which A is a substituted sulphonamide, and the substituent is an alkyl chain of 1 to 6, preferably 1 to 4 carbon atoms, or a phenyl or toluyll group.

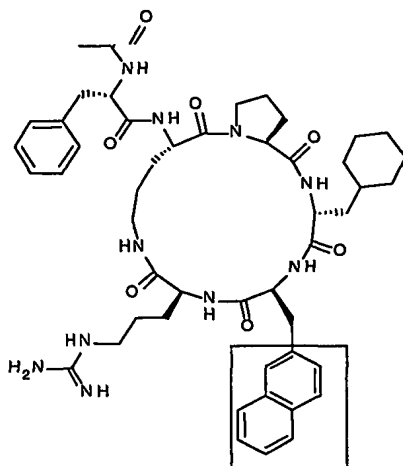
8. A method according to any one of claims 1 to 6, in  
15 which the antagonist is a C5a receptor antagonist which has antagonist activity against C5aR, and has no C5a agonist activity.

9. A method according to any one of claims 1 to 7, in  
20 which the compound has a receptor affinity  $IC_{50} < 25 \mu M$ , and an antagonist potency  $IC_{50} < 1 \mu M$ .

10. A method according to any one of claims 1 to 8,  
in which the compound is selected from the group consisting  
of compounds 1 to 6, 10 to 15, 17, 19, 20, 22, 25, 26, 28,  
30, 31, 33 to 37, 39 to 45, 47 to 50, 52 to 58 and 60 to 70  
25 described in International patent application  
No. PCT/AU02/01427.

11. A method according to claim 10, in which the  
compound is PMX53 (compound 1), compound 33, compound 60 or  
compound 45.

30 12. A method according to claim 10, in which the  
compound is PMX53, having the formula



13. The use of a C5a receptor antagonist for the manufacture of a medicament for use in the treatment of a fibrotic condition.

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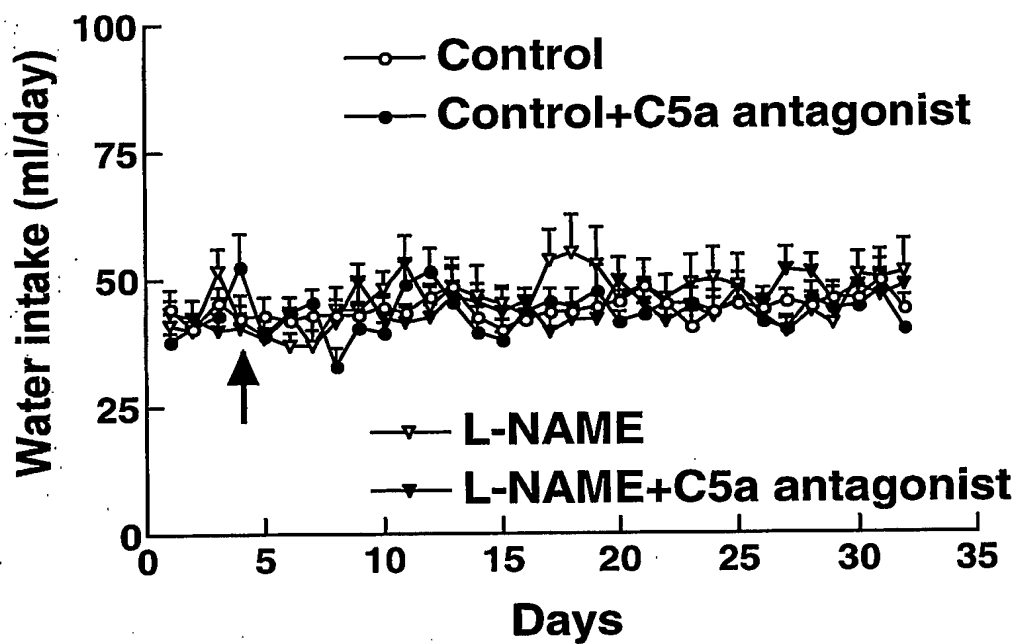


Figure 1a

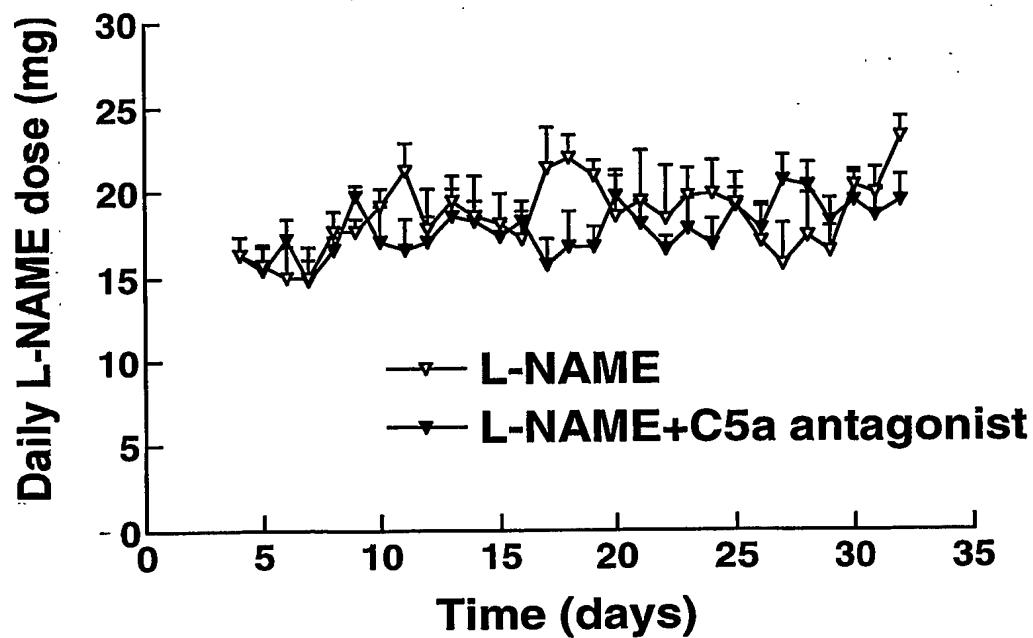


Figure 1b

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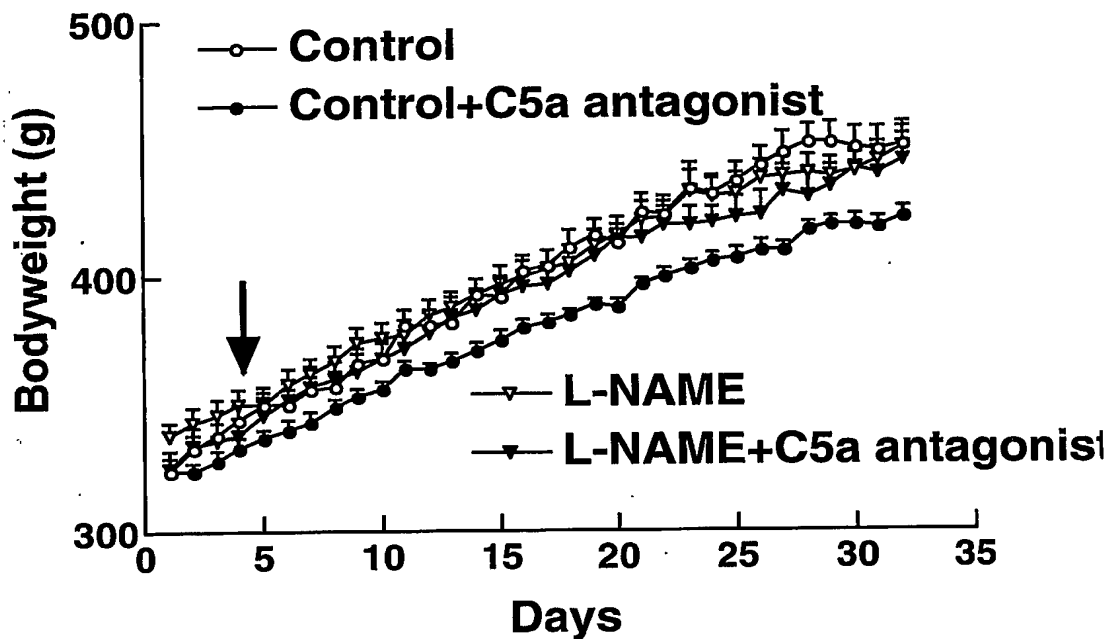


Figure 2

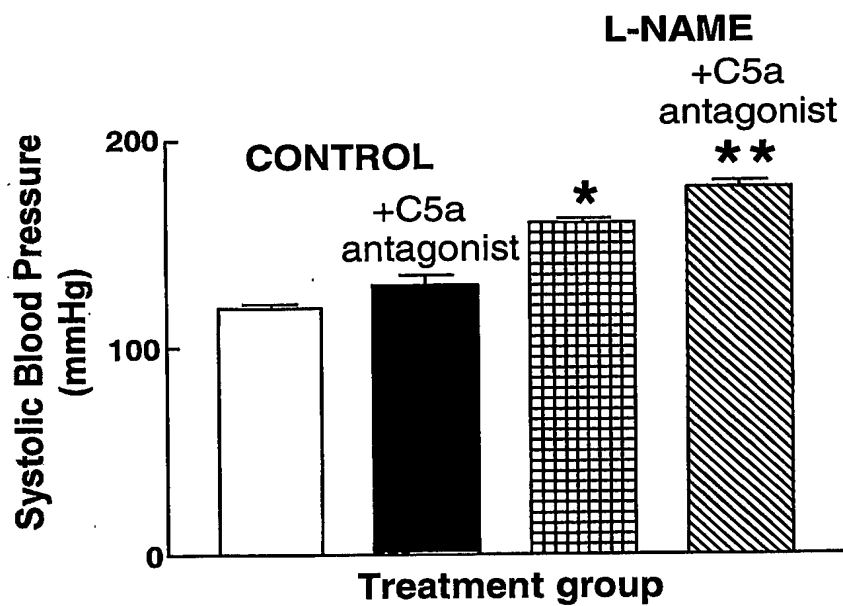


Figure 3

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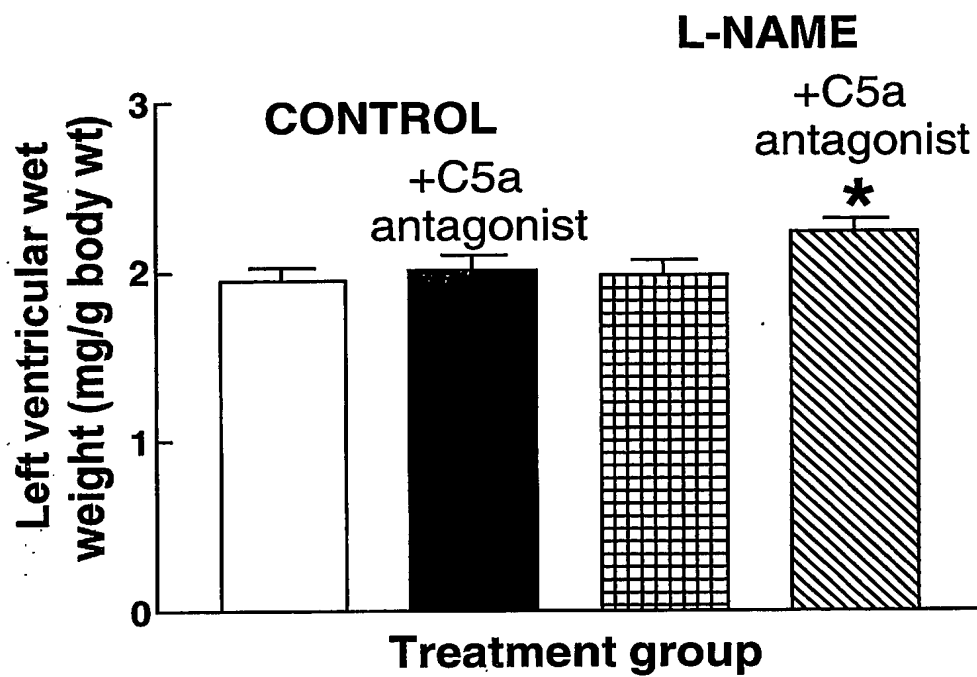


Figure 4

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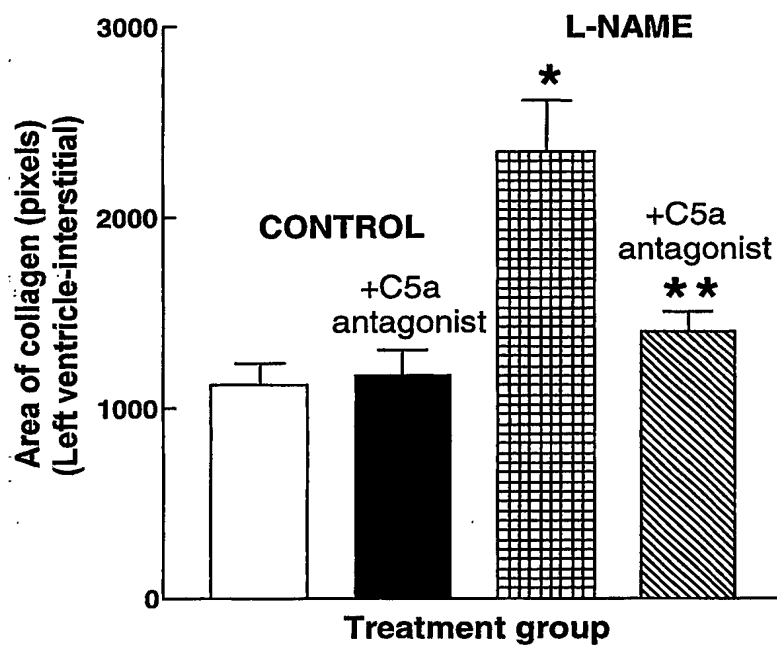


Figure 5a

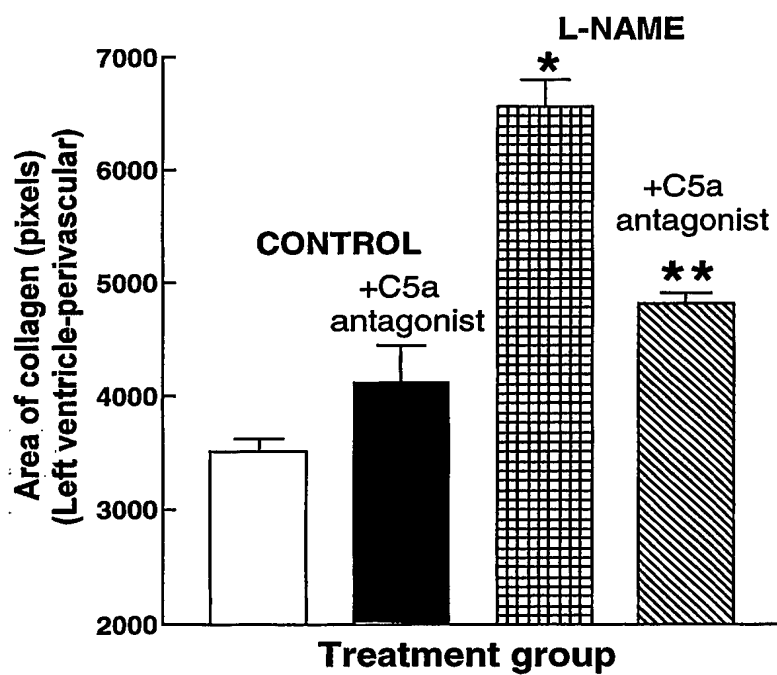


Figure 5b

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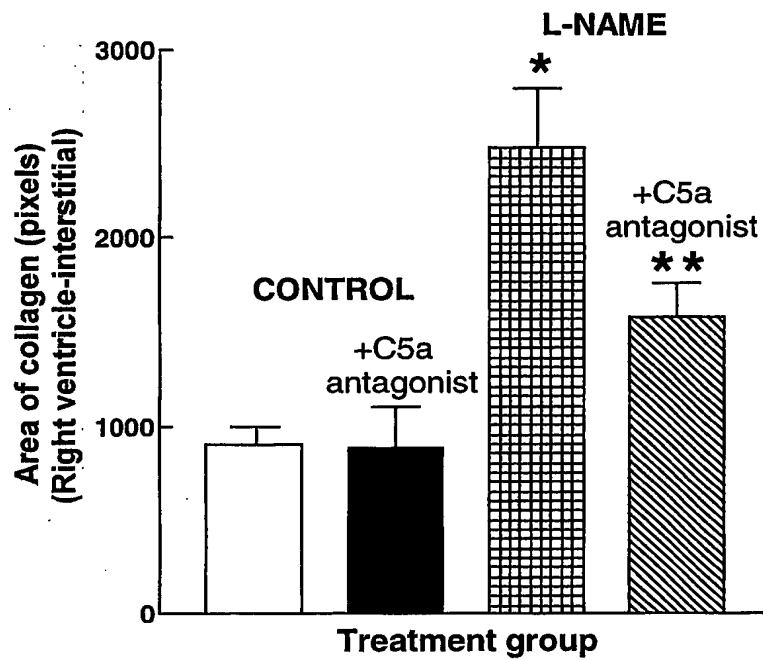


Figure 6a

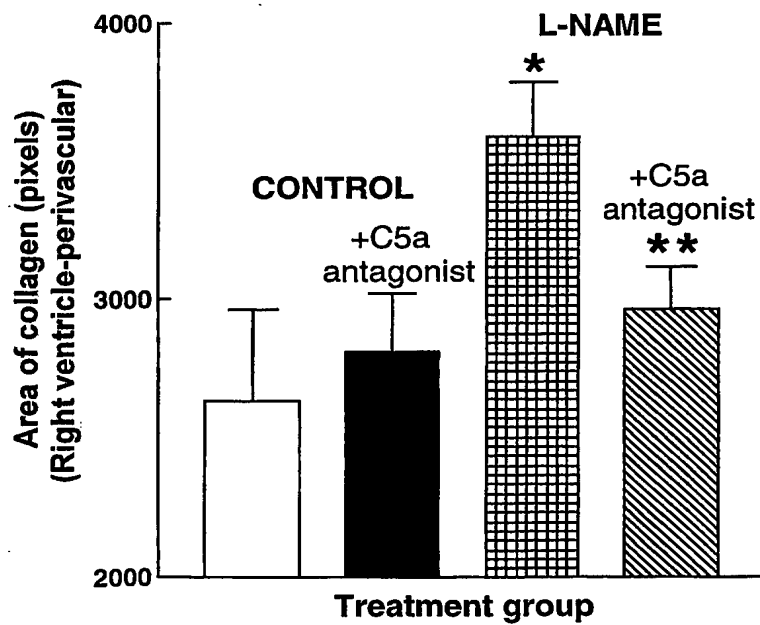


Figure 6b

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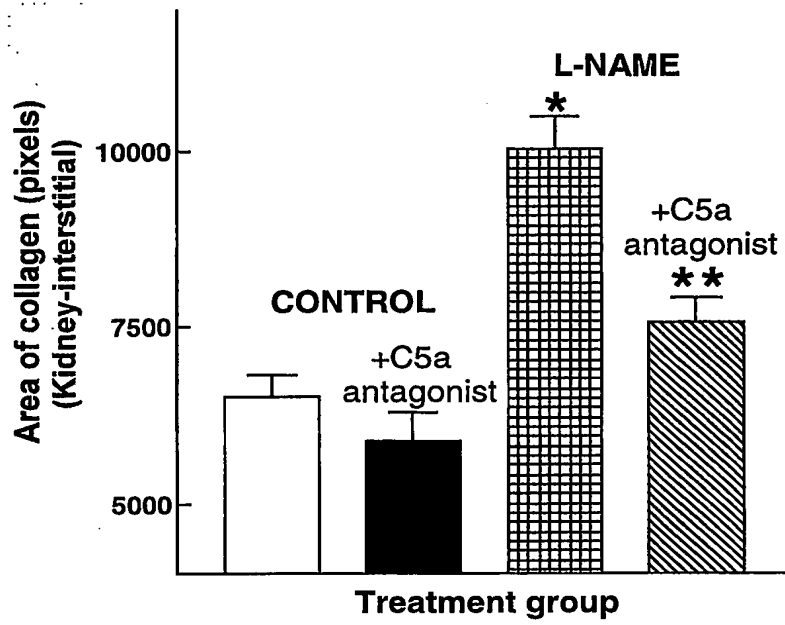


Figure 7a

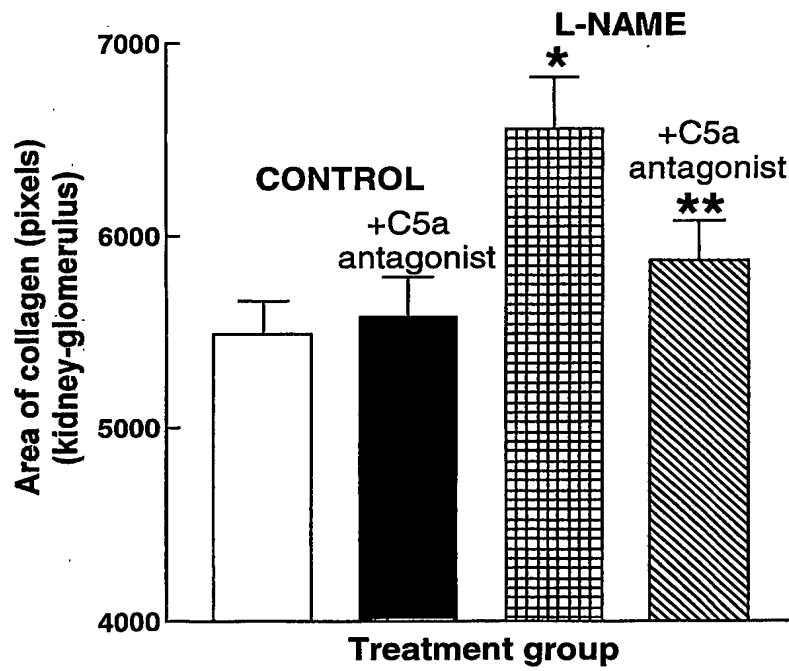


Figure 7b

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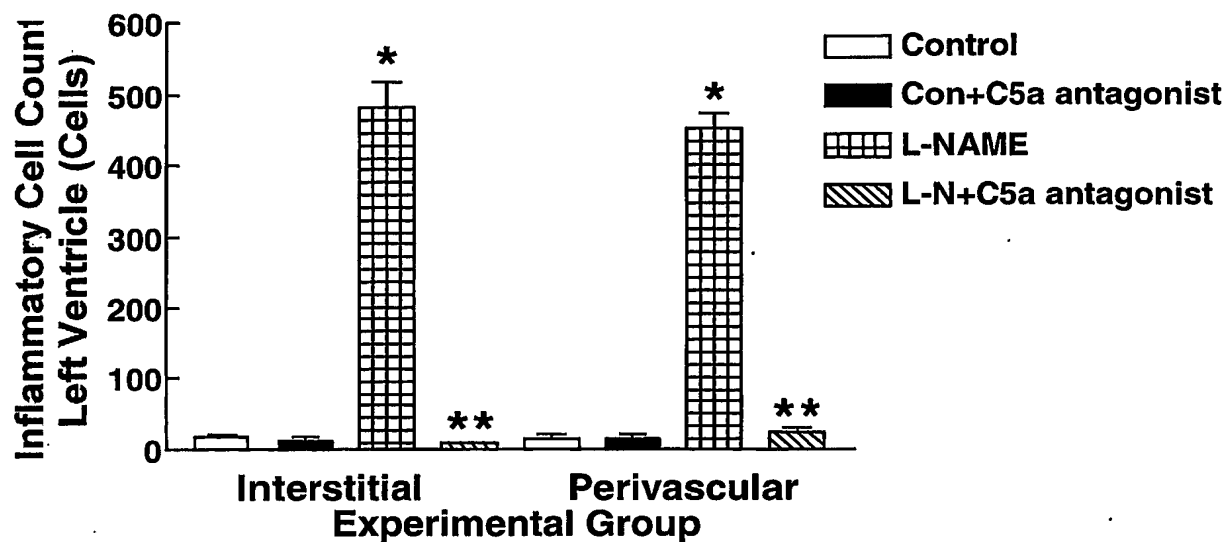


Figure 8a

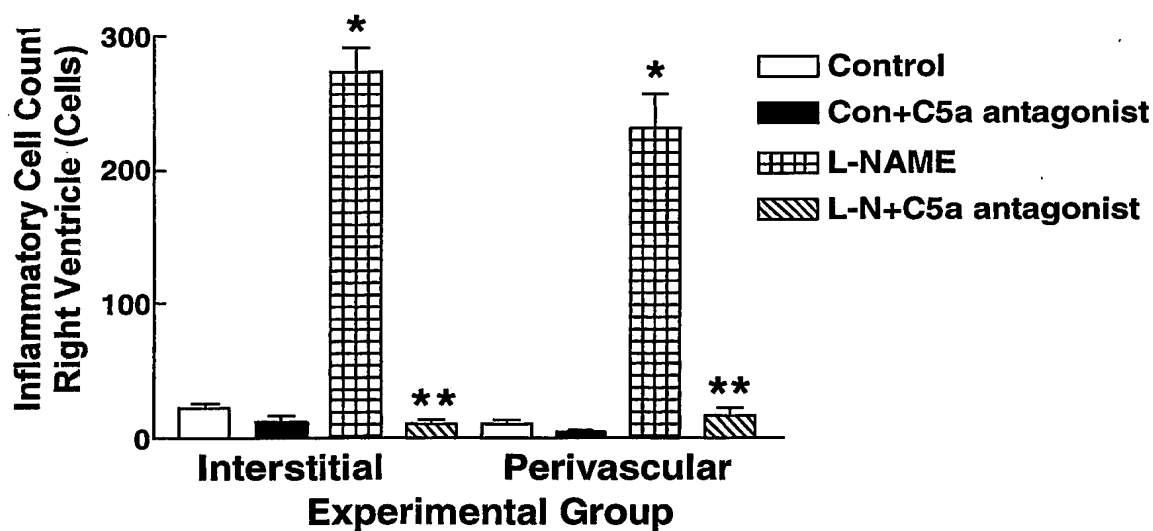


Figure 8b

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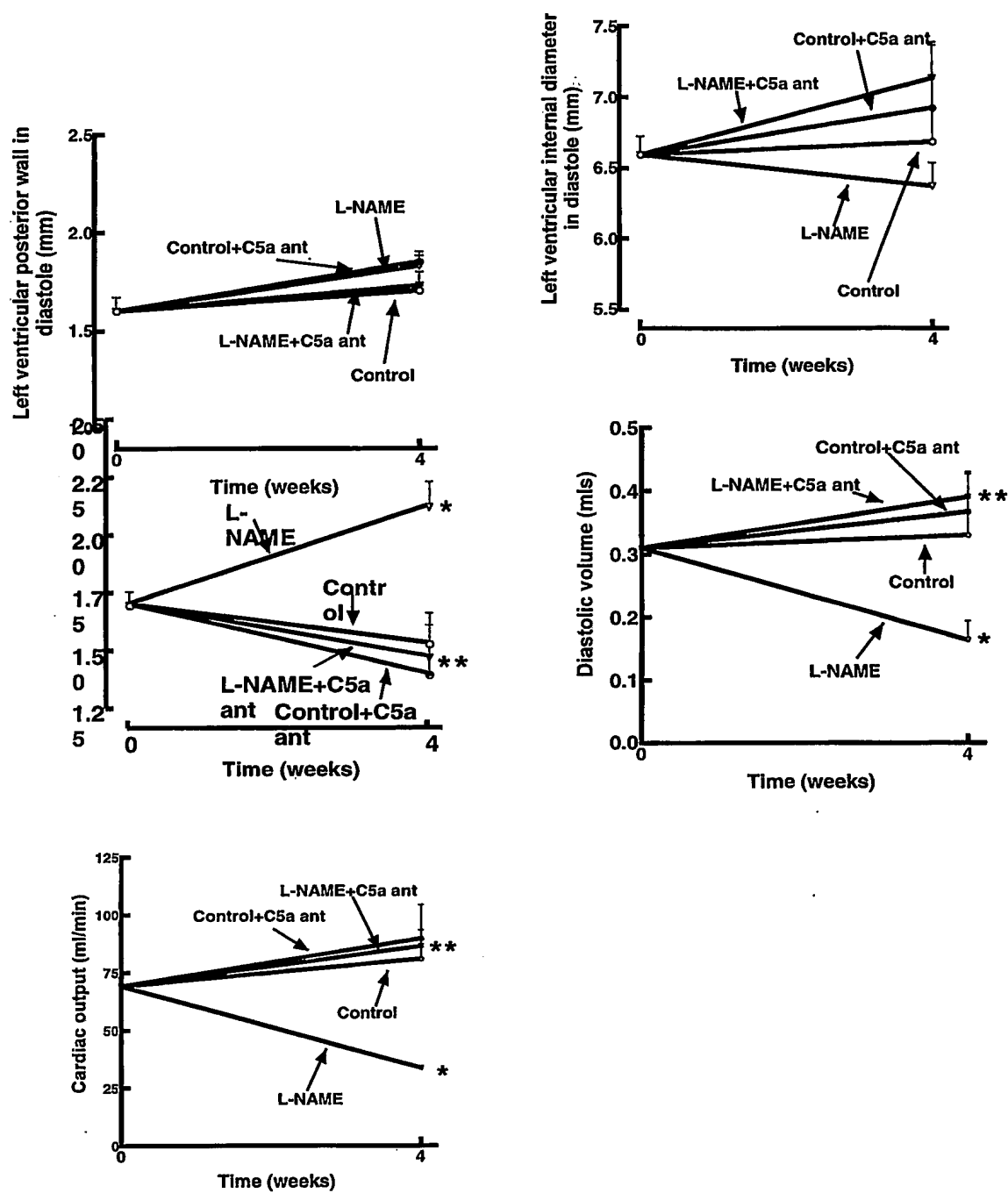


Figure 9

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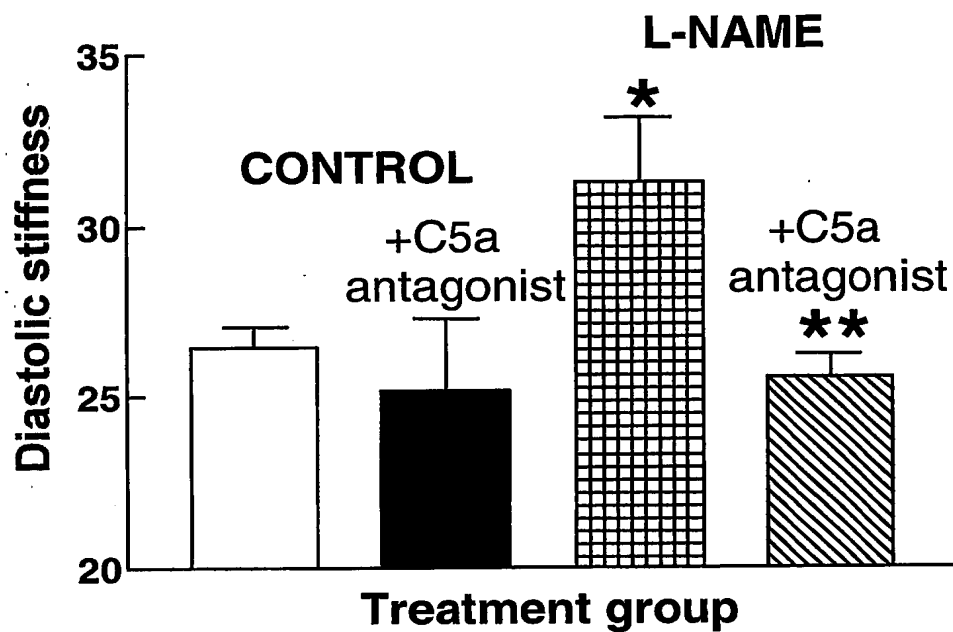


Figure 10

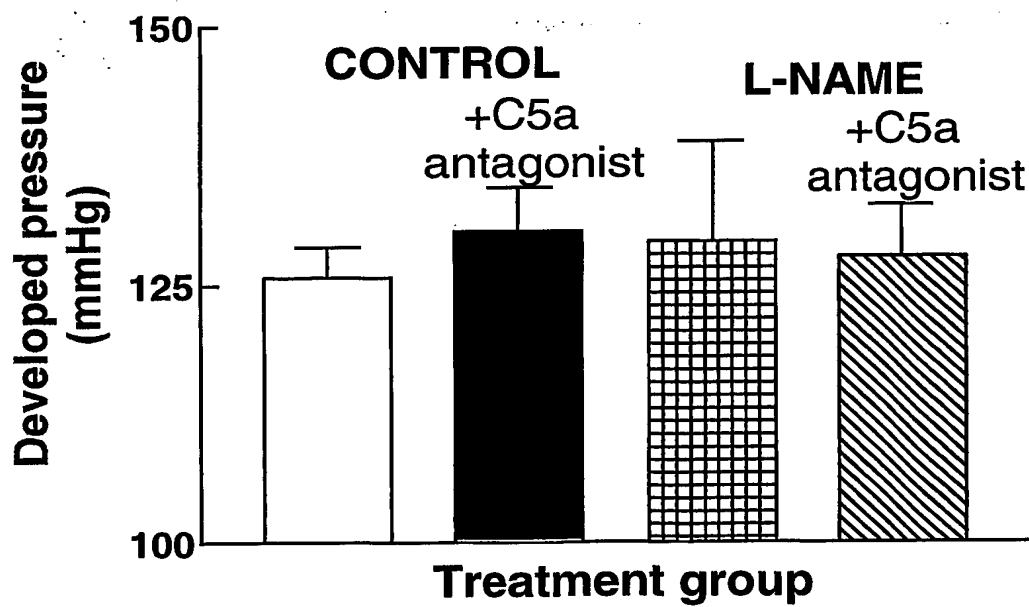


Figure 11

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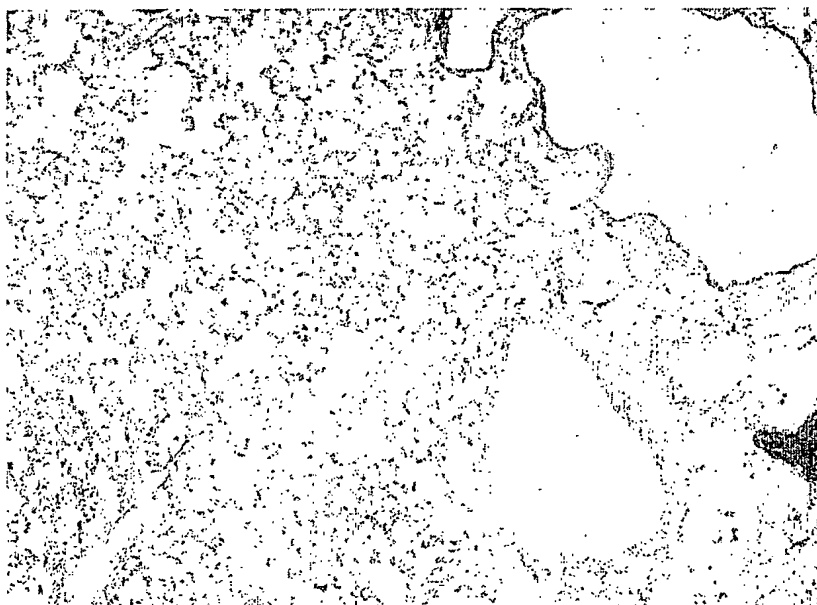


Figure 12a

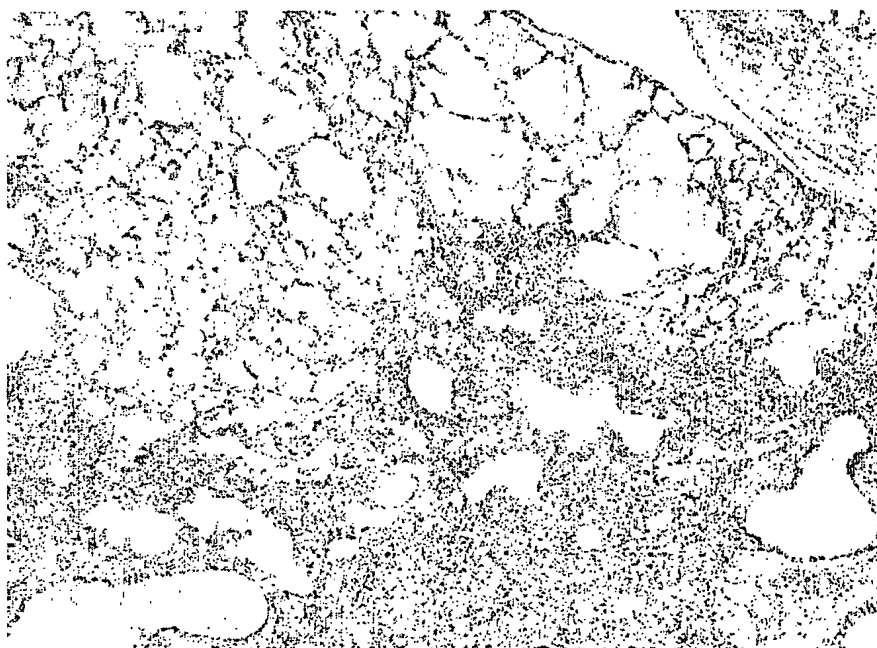


Figure 12b

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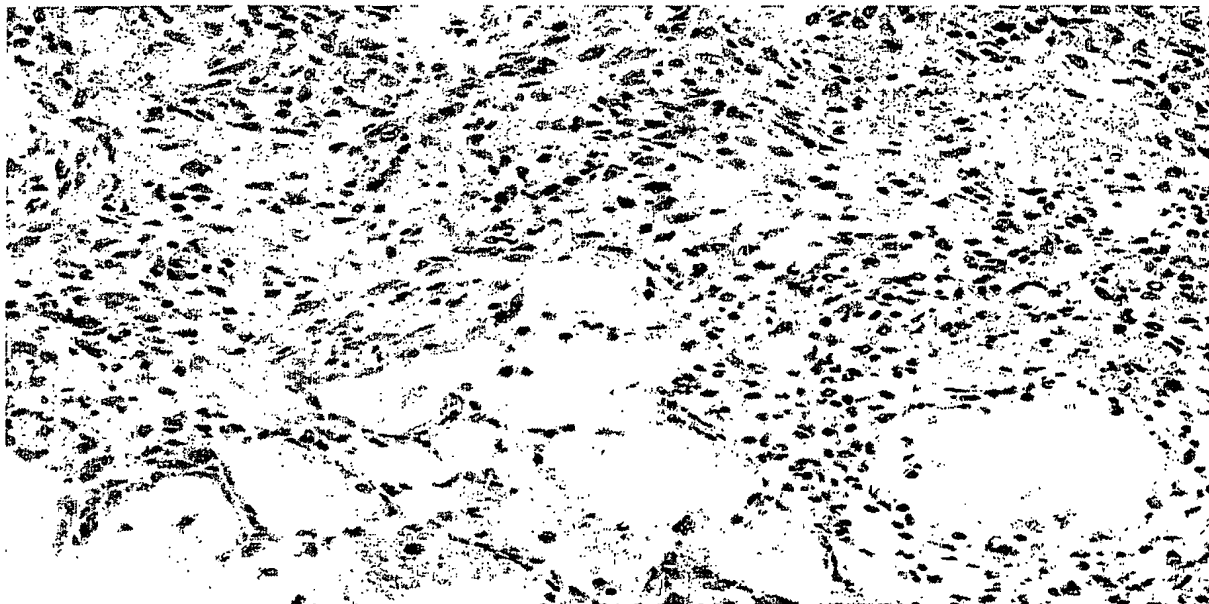


Figure 13a

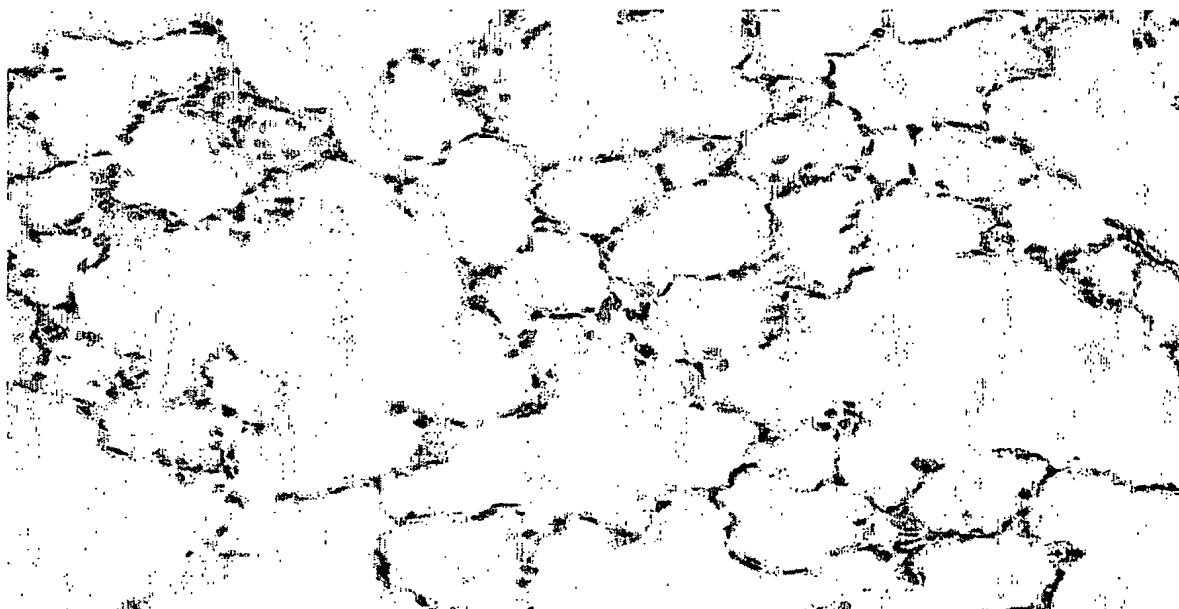


Figure 13b

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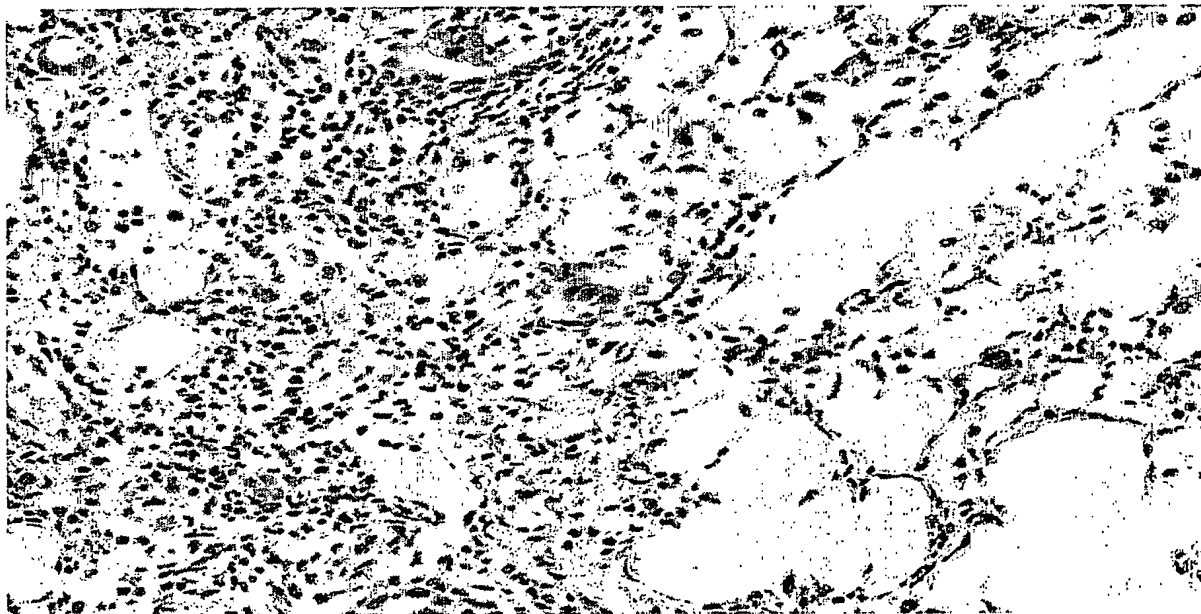


Figure 14

**Effect of PMX53 on  
Bleomycin-Induced Collagen  
Deposition in Early Stage (7-10  
days)**

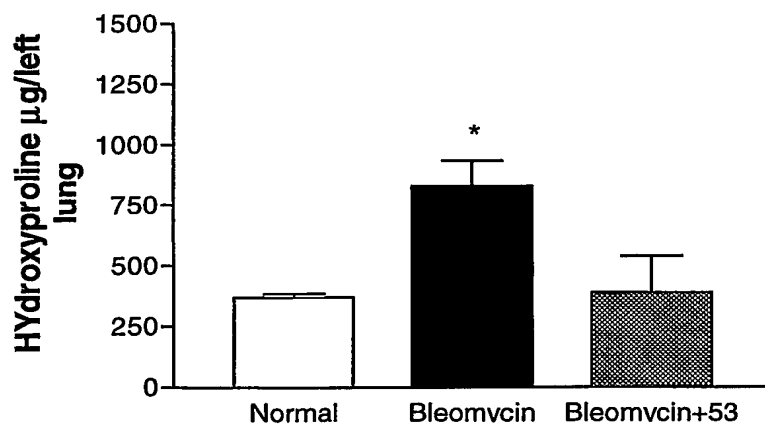


Figure 15

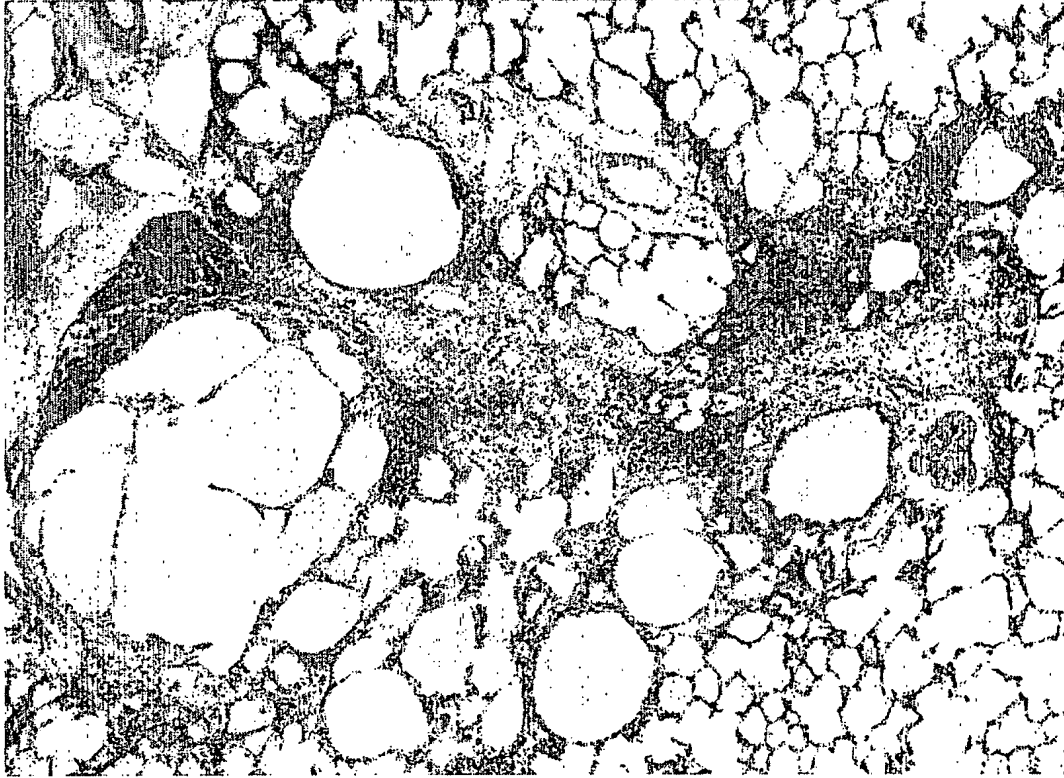


Figure 16

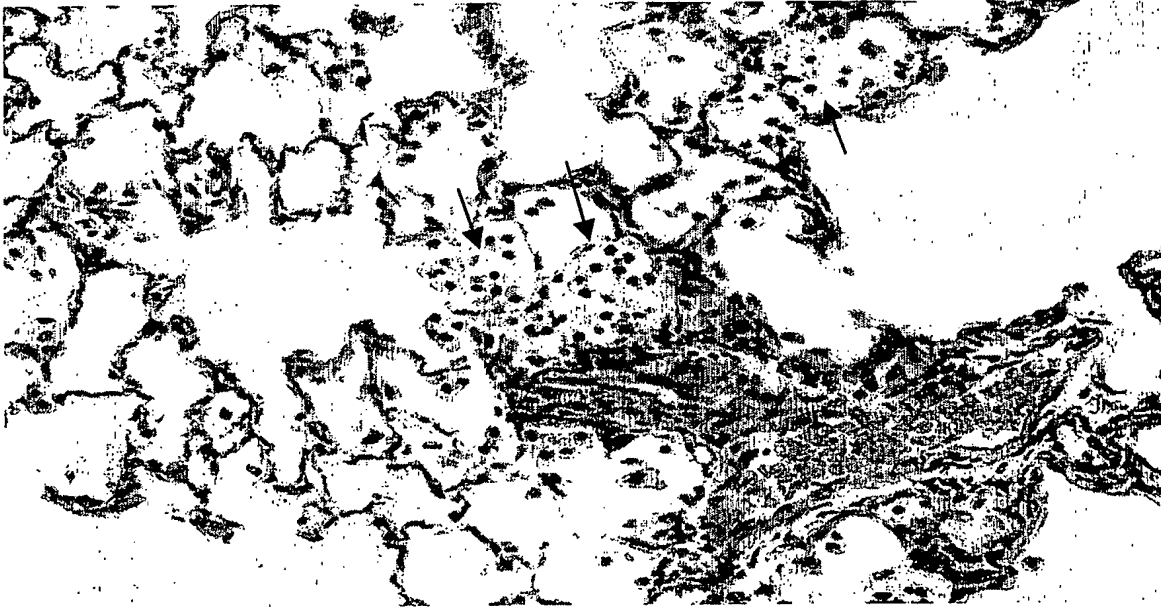


Figure 17a

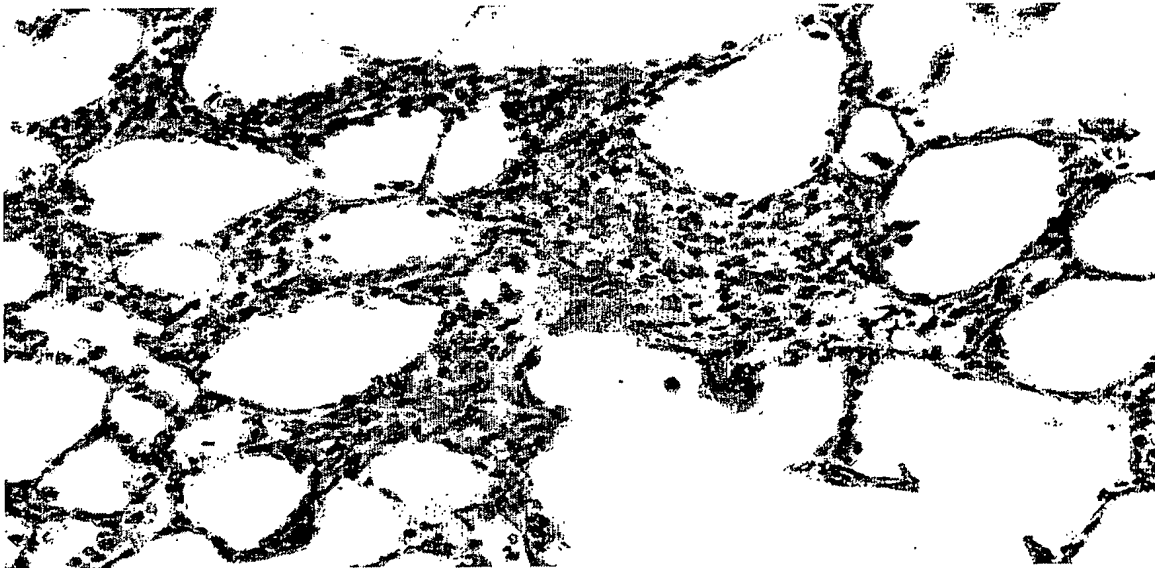


Figure 17b

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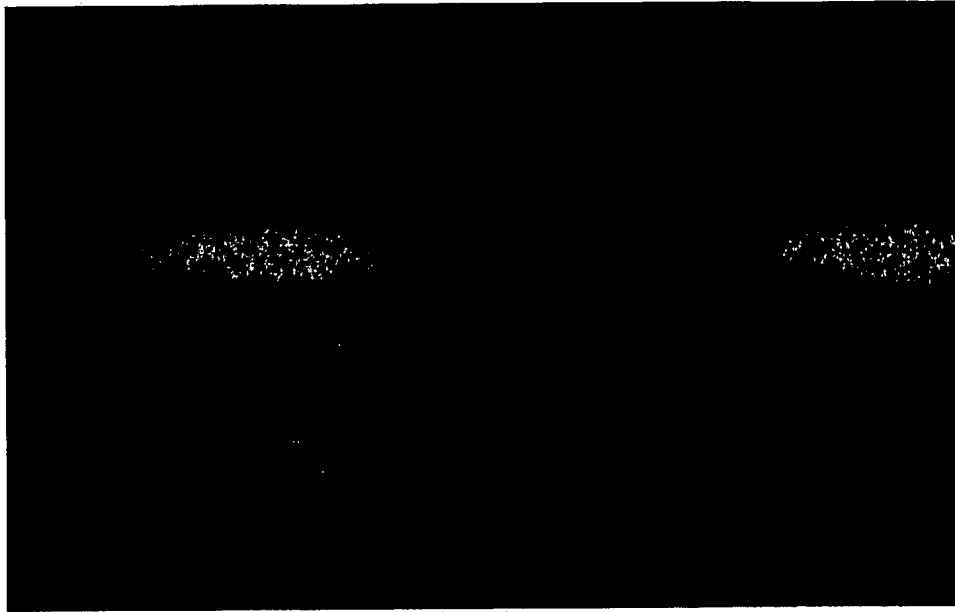


Figure 18a



Figure 18b

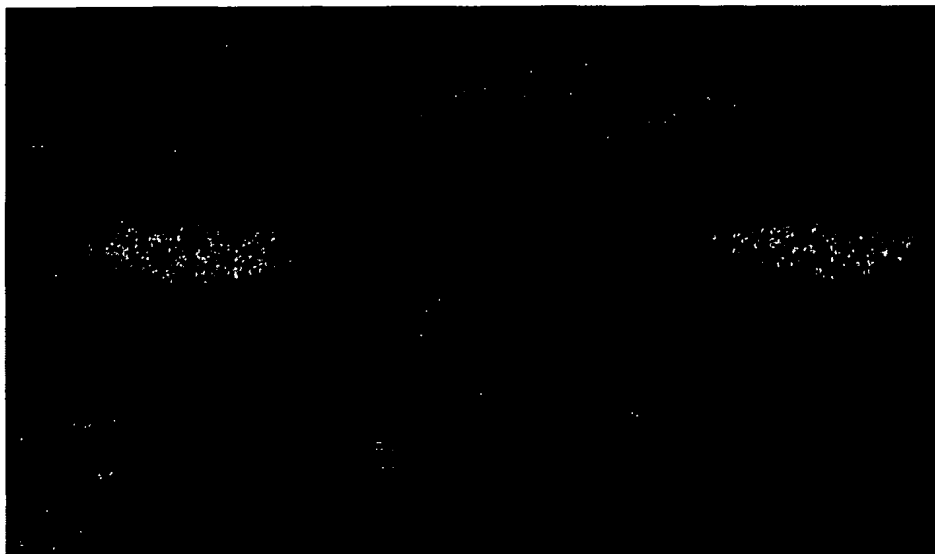


Figure 18c

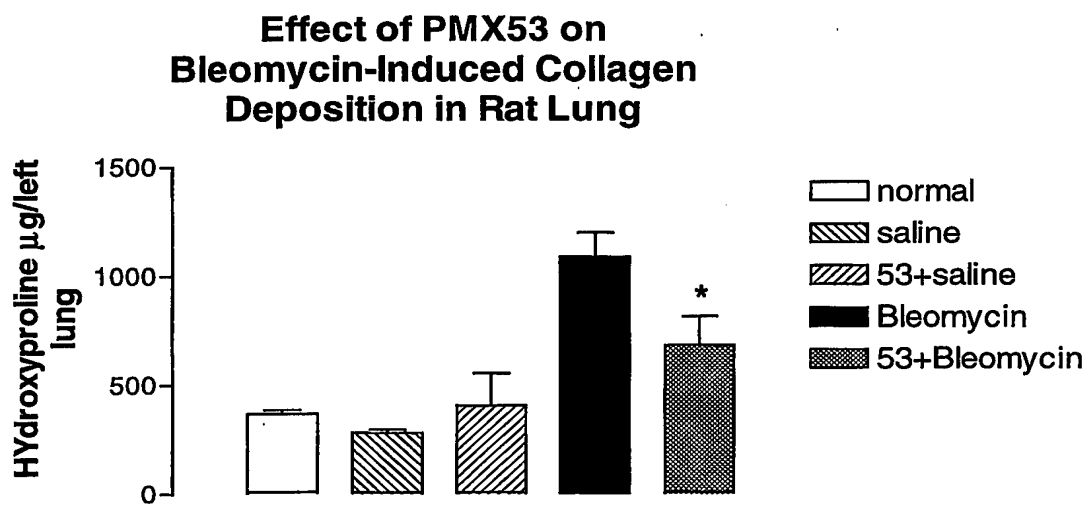
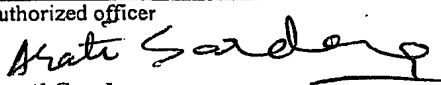


Figure 19

## INTERNATIONAL SEARCH REPORT

 International application No.  
**PCT/AU03/00415**

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int. Cl. <sup>7</sup> : A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent WPAT and Medline keywords: Fibrot?, Fibros?, myocardial(infarction, diabetes, C5a, C5aR, receptor?, antagonist, antibod? and like terms.		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,692,511 A (Hahn Gary. S.) 8 September 1987 See abstract	1-13
Y	AU 80926/98 A (THE UNIVERSITY OF QUEENSLAND) 19 January 1999 See pages 1 and 2	1-13
X	WO 02/14265 A (WELFIDE CORPORATION) 21 February 2002 See abstract	1-13
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 27 May 2003		Date of mailing of the international search report <b>19 JUN 2003</b>
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929		Authorized officer  <b>Arati Sardana</b> Telephone No : (02) 6283 2627

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/AU03/00415**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member	
US	4692511	EP	305615		
AU	80926/98	WO	9900406	EP	1017713
WO	200214265	AU	200177751	EP	1308438
END OF ANNEX					

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

RECEIVED

04 AUG 2004

PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference VS:CE:FP17710	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).	
International Application No.  <b>PCT/AU2003/000415</b>	International Filing Date (day/month/year) 7 April 2003	Priority Date (day/month/year) 8 April 2002
International Patent Classification (IPC) or national classification and IPC  Int. Cl. <sup>7</sup> A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00		
Applicant  PROMICS PTY LIMITED et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

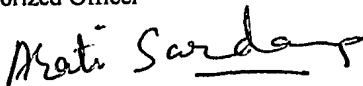
2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 9 sheet(s).

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26 September 2003	Date of completion of the report 2 July 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer   <b>ARATI SARDANA</b> Telephone No. (02) 6283 2627

**I. Basis of the report****1. With regard to the elements of the international application:\***

- ☐ the international application as originally filed.
- ☒ the description, pages 2-4, 7-29, 31, 33-37 and 42 as originally filed,  
pages , filed with the demand,  
pages 1, 5, 6, 30 and 32 received on 01 June 2004 with the letter of 01 June 2004
- ☒ the claims, pages , as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages 38-41 received on 01 June 2004 with the letter of 01 June 2004
- ☒ the drawings, pages 1/16-16/16 as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

**4. ☐ The amendments have resulted in the cancellation of:**

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-21	YES
	Claims	NO
Inventive step (IS)	Claims 2-21	YES
	Claims 1	NO
Industrial applicability (IA)	Claims 1-21	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)****CITATIONS:****D1: US 4,692,511 A****D2: AU 80926/98 A****D3: WO 02/14265 A****EXPLANATION:****NOVELTY:**

Amended claims 1-21 are novel in light of the disclosure of documents D1 to D3.

**INVENTIVE STEP (IS): Claim 1**

The Attorney has argued in her submission with respect to US 4,692,511 that there are no experimental results to support the assertion that the compounds disclosed in the citation are effective for treatment of fibrotic condition.

However given the disclosure in US 4,692,511 that C5a receptor antagonist peptides disclosed there in are particularly useful in the treatment of fibrotic condition idiopathic pulmonary fibrosis, the skilled person would reasonably be expected to use peptides of US 4,692,511 in the treatment of fibrosis with a reasonable expectation of success. Therefore claim 1 would still lack an inventive step.

16/PRTS

WO 03/086448

PCT/AU03/00415

1

Use of C5a receptor antagonist  
in the treatment of fibrosis

REPLACED BY  
ART 34 AMDTFIELD OF THE INVENTION

5           This invention relates to the use of an antagonist  
of a G protein-coupled receptor in the prevention and/or  
treatment of fibrosis, such as the treatment of fibrosis  
associated with myocardial infarction, diabetes, or certain  
pulmonary conditions. In a preferred embodiment the  
10 antagonist is a C5a receptor antagonist, more preferably a  
cyclic peptide antagonist of the C5a receptor.

BACKGROUND OF THE INVENTION

15           All references, including any patents or patent  
applications, cited in this specification are hereby  
incorporated by reference. No admission is made that any  
reference constitutes prior art. The discussion of the  
references states what their authors assert, and the  
applicants reserve the right to challenge the accuracy and  
20 pertinency of the cited documents. It will be clearly  
understood that, although a number of prior art  
publications are referred to herein, this reference does  
not constitute an admission that any of these documents  
forms part of the common general knowledge in the art, in  
25 Australia or in any other country.

G protein-coupled receptors are prevalent  
throughout the human body, comprising approximately 60% of  
known cellular receptor types. They mediate signal  
transduction across the cell membrane for a very wide range  
30 of endogenous ligands and consequently participate in a  
diverse array of physiological and pathophysiological  
processes, including, but not limited to, those associated  
with cardiovascular, central and peripheral nervous system  
reproductive, metabolic, digestive, immunoinflammatory, and  
35 growth disorders, as well as other cell regulatory and  
proliferative disorders. Agents which selectively modulate

REPLACED BY  
ART 34 AMDT

et al. 1997).

The effects of drug-induced ad hypertension-induced pulmonary and renal fibrosis in animal models can be prevented or partially reversed by compounds which act  
5 by suppressing inflammatory events and down-regulating lung pro-collagen I over-expression (Iyer et al., 1999a,b).

We have shown that the administration of pirfenidone or spironolactone can prevent and partially reverse cardiac fibrosis and the increase in cardiac  
10 stiffness which occurs in streptozotocin-induced diabetes in rats (Miric G, et al., 2001) It is thought that pirfenidone acts by inhibiting increased TGF- $\beta$  mRNA expression, allowing an increase in expression of metalloproteases which degrade the collagen I laid down  
15 during fibrosis. The mode of action of spironolactone is at present unknown. Spironolactone is a steroid analogue which is primarily used as a diuretic; pirfenidone (5-methyl-1-phenyl-2-(1H)-pyridone), an investigational compound being investigated as an anti-fibrotic agent in a  
20 number of indications.

It would be highly desirable to identify other therapeutically or prophylactically active agents for use in the treatment or prevention of fibrosis.

The overexpression or underregulation of a G-protein-coupled receptor, the C5a receptor, has been  
25 implicated in immune-system mediated events such as inflammation. Agents which influence C5a receptor activity, such as C5a receptor antagonists, have the potential to mediate inflammatory events, and may provide a  
30 means of therapeutic or prophylactic intervention, but have not previously been suggested as potential agents in the treatment or prevention of fibrosis.

We have now surprisingly found that a cyclic peptide with C5a receptor antagonist has the ability to  
35 ameliorate cardiac fibrosis in an animal model of this condition.

REPLACED BY  
ART 34 AMDTSUMMARY OF THE INVENTION

According to a first aspect, the invention  
5 provides a method of prevention, treatment or alleviation  
of a fibrotic condition, comprising the step of  
administering an effective amount of an antagonist of a G  
protein-coupled receptor to a subject in need of such  
treatment.

10 The use of any compound having activity as an  
antagonist of a G protein-coupled receptor, and  
particularly as a C5a receptor antagonist, is contemplated,  
including but not limited to those disclosed in our earlier  
International patent applications No. PCT/AU98/00490 or No.  
15 PCT/AU02/01427 or in International patent applications No.  
PCT/US00/11187 by Neurogen Corporation and No.  
PCT/JP01/06902 by Welfide Corporation, or antibody  
antagonists such as those disclosed in PCT/US00/24219 or US  
patent No. 6355245. The entire disclosures of all of these  
20 specifications are incorporated herein by this cross-  
reference.

More preferably the C5a receptor antagonist is a  
peptide or a peptidomimetic compound, and more preferably is  
a cyclic peptide or a cyclic peptidomimetic compound. Even  
25 more preferably the compound is a cyclic peptide or a  
cyclic peptidomimetic compound of PCT/AU98/00490 or  
PCT/AU02/01427.

Still more preferably the antagonist is a compound  
which

- 30 (a) is an antagonist of a G protein-coupled receptor,  
(b) has substantially no agonist activity, and  
(c) is a cyclic peptide or peptidomimetic compound of  
formula I

REPLACED BY  
ART 34 AMDT

Xylocaine to prevent airway spasm, the rats were intubated and a slow injection of bleomycin or saline control was completed. The rats were then rotated gently for about 1-2 minutes to allow the solution to diffuse evenly into both lungs (Christensen et al 2000). Rats were kept in the fume cupboard until totally recovered, and then monitored for up to 18 days. Body weight, food and water intake, and respiration were monitored daily.

Respiration was elevated as follows: Score 0, normal respiration; Score 1, increased rate of breathing; and Score 2, mouth open respiration. Rats were euthanased before the end of the experimental period, if they consistently lost more than 10% bodyweight for 48 hours, had Score 2 respiration or had Score 1 respiration for 48 hours.

At the end of this period the rats were killed by exsanguination under anaesthesia, so that the lungs were clear of blood. For each rat, the left lung was immediately frozen in liquid nitrogen and stored at  $-20^{\circ}\text{C}$  for quantitative collagen analysis using hydroxyproline assay. The right lung was fully inflated and fixed with 10% formulated formalin by airway gravity fixation at a pressure of 30 cm water for 1 minute. Haematoxylin and eosin (H&E) and Picro Sirius Red (PR) staining for collagen were performed to assess collagen deposition in the lung. For quantitation of collagen stained with PR, polarized light images were converted to grey scale, and the total number of white pixels (specific for collagen) per image was determined as a percentage of the total pixel area. The procedure was applied to a total of four fields in the alveolar area and two fields in the peribronchial area and blood vessels per sample (Wang et al, 2000). The largest lobe of the right lung (from 4 lobes) in each rat was chosen. The data was analysed using the program "Sion Image".

Hydroxyproline assay was performed by the method

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ART 34 AMDT

Table 1.

Lung weight and body weight in bleomycin-induced pulmonary fibrosis (7-9 days)

5

Condition	Left lung weight (g)	Body weight (g)	Ratio $\times 10^{-3}$
Normal	0.507 + 0.003	240.6 + 4.667	1.9 + 0.36
Bleomycin	1.004 + 0.04	226 + 8.083	4.47 + 0.46**
Bleomycin + PMX53	0.974 + 0.132	228 + 7.583	4.25 + 1.07**

\*\* :  $P < 0.001$ ,  $n=3$ , compared to normal rats.

Under the microscope, numbers of inflammatory cells, including PMNs, macrophages, lymphocytes etc. were observed in the alveolar spaces, with massive leakage of plasma and red blood cells; this is illustrated in Figure 13a. The size and number of type II AECs in the alveolar spaces was clearly increased, as shown in Figure 13b, while in normal lung, the type II AECs covered only 5 - 10% of the surface area of the alveoli, as shown in Figure 14.

There was no significant difference in histology between drug-treated and non-treated groups. Collagen deposition in bleomycin instillation lungs showed a significant increase compared to normal lungs ( $P < 0.01$ ,  $n=3$ ); saline instillation lungs ( $P < 0.01$ ,  $n=3$ ); and saline instillation with PMX53-treated lungs ( $P < 0.01$ ,  $n=3$ ). However, there was no significant difference between the drug-treated group and non-treated group ( $P > 0.01$ ,  $n=4$ ). These results are summarised in Figure 15.

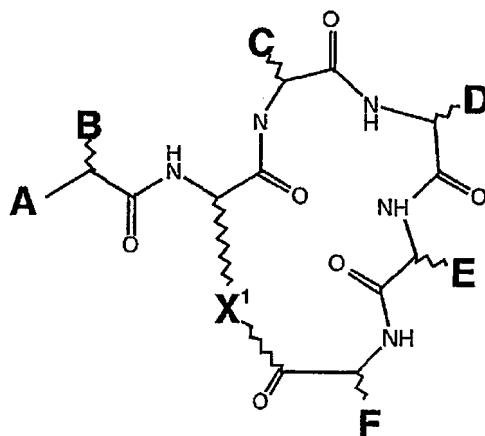
25

## 2. Pulmonary fibrosis

Eighteen days after intra-tracheal instillation of bleomycin, the degree of oedema was reduced in bleomycin-instilled lungs, and the lung/body weight ratio did not

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ART 34 AMDTCLAIMS

1. A method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of  
5 administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.
2. A method according to claim 1, in which the antagonist is a C5a receptor antagonist.
- 10 3. A method according to claim 1 or claim 2, in which the antagonist is a peptide or a peptidomimetic compound.
4. A method according to claim 3, in which the antagonist is a cyclic peptide or a cyclic peptidomimetic  
15 compound.
5. A method according to any one of claims 1 to 3, in which the antagonist
- (a) is an antagonist of a G protein-coupled receptor,
- 20 (b) has substantially no agonist activity, and
- (c) is a cyclic peptide or peptidomimetic compound of formula I



where A is H, alkyl, aryl, NH<sub>2</sub>, NH-alkyl,

REPLACED BY  
ART 34 AMDT

N(alkyl)<sub>2</sub>, NH-aryl, NH-acyl, NH-benzoyl, NHSO<sub>3</sub>, NHSO<sub>2</sub>-alkyl, NHSO<sub>2</sub>-aryl, OH, O-alkyl, or O-aryl;

5 B is an alkyl, aryl, phenyl, benzyl, naphthyl or indole group, or the side chain of a D- or L-amino acid such as L-phenylalanine or L-phenylglycine, but is not the side chain of glycine, D-phenylalanine, L-homophenylalanine, L-tryptophan, L-homotryptophan, L-tyrosine, or L-homotyrosine;

10 C is a small substituent, such as the side chain of a D-, L- or homo-amino acid such as glycine, alanine, leucine, valine, proline, hydroxyproline, or thioproline, but is preferably not a bulky substituent such as isoleucine, phenylalanine, or cyclohexylalanine;

15 D is the side chain of a neutral D-amino acid such as D-Leucine, D-homoleucine, D-cyclohexylalanine, D-homocyclohexylalanine, D-valine, D-norleucine, D-homonorleucine, D-phenylalanine, D-tetrahydroisoquinoline, D-glutamine, D-glutamate, or D-tyrosine, but is preferably not a small substituent such as the side chain of glycine or D-alanine, a bulky planar side chain such as D-tryptophan, or a bulky charged side chain such as D-arginine or D-Lysine;

25 E is a bulky substituent, such as the side chain of an amino acid selected from the group consisting of L-phenylalanine, L-tryptophan and L-homotryptophan, or is L-1-naphthyl or L-3-benzothienyl alanine, but is not the side chain of D-tryptophan, L-N-methyltryptophan, L-homophenylalanine, L-2-naphthyl L-tetrahydroisoquinoline, L-cyclohexylalanine, D-leucine, L-fluorenylalanine, or 30 L-histidine;

F is the side chain of L-arginine, L-homoarginine, L-citrulline, or L-canavanine, or a bioisostere thereof, ie. a side chain in which the terminal guanidine or urea group is retained, but the carbon backbone is replaced by a 35 group which has different structure but is such that the side chain as a whole reacts with the target protein in the

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ATT 34 AMDT

same way as the parent group; and

X is  $-(CH_2)_nNH-$  or  $(CH_2)_nS-$ , where n is an integer of from 1 to 4, preferably 2 or 3;  $-(CH_2)_2O-$ ;

$-(CH_2)_3O-$ ;  $-(CH_2)_3-$ ;  $-(CH_2)_4-$ ;  $-CH_2COCHRNH-$ ; or

5  $-CH_2-CHCOCHRNH-$ , where R is the side chain of any common or uncommon amino acid.

6. A method according to claim 5, in which A is an acetamide group, an aminomethyl group, or a substituted or unsubstituted sulphonamide group.

10 7. A method according to claim 6, in which A is a substituted sulphonamide, and the substituent is an alkyl chain of 1 to 6, preferably 1 to 4 carbon atoms, or a phenyl or toluyl group.

8. A method according to any one of claims 1 to 6, in  
15 which the antagonist is a C5a receptor antagonist which has antagonist activity against C5aR, and has no C5a agonist activity.

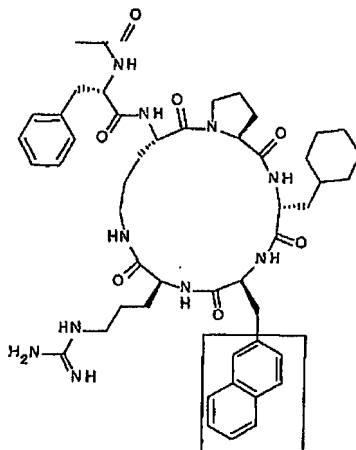
9. A method according to any one of claims 1 to 7, in  
20 which the compound has a receptor affinity  $IC_{50} < 25 \mu M$ , and an antagonist potency  $IC_{50} < 1 \mu M$ .

10. A method according to any one of claims 1 to 8,  
in which the compound is selected from the group consisting  
of compounds 1 to 6, 10 to 15, 17, 19, 20, 22, 25, 26, 28,  
30, 31, 33 to 37, 39 to 45, 47 to 50, 52 to 58 and 60 to 70  
25 described in International patent application  
No. PCT/AU02/01427.

11. A method according to claim 10, in which the  
compound is PMX53 (compound 1), compound 33, compound 60 or  
compound 45.

30 12. A method according to claim 10, in which the  
compound is PMX53, having the formula

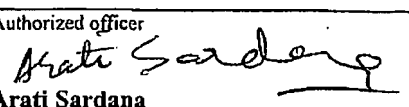
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ART 34 AMDT



13. The use of a C5a receptor antagonist for the manufacture of a medicament for use in the treatment of a fibrotic condition.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU03/00415

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>												
Int. Cl. <sup>7</sup> : A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00												
According to International Patent Classification (IPC) or to both national classification and IPC												
<b>B. FIELDS SEARCHED</b>												
Minimum documentation searched (classification system followed by classification symbols)												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent WPAT and Medline keywords: Fibrot?, Fibros?, myocardial()infarction, diabetes, C5a, C5aR, receptor?, antagonist, antibod? and like terms.												
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	US 4,692,511 A (Hahn Gary. S.) 8 September 1987 See abstract	1-13										
Y	AU 80926/98 A (THE UNIVERSITY OF QUEENSLAND) 19 January 1999 See pages 1 and 2	1-13										
X	WO 02/14265 A (WELFIDE CORPORATION) 21 February 2002 See abstract	1-13										
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 27 May 2003		Date of mailing of the international search report 19 JUN 2003										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer  Arati Sardana Telephone No : (02) 6283 2627										

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/AU03/00415**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member	
US	4692511	EP	305615		
AU	80926/98	WO	9900406	EP	1017713
WO	200214265	AU	200177751	EP	1308438
END OF ANNEX					

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000415

**I. Basis of the report****1. With regard to the elements of the international application:\***

- ☐ the international application as originally filed.
- ☒ the description, pages 2-4, 7-29, 31, 33-37 and 42 as originally filed,  
pages , filed with the demand,  
pages 1, 5, 6, 30 and 32 received on 01 June 2004 with the letter of 01 June 2004
- ☒ the claims, pages , as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages 38-41 received on 01 June 2004 with the letter of 01 June 2004
- ☒ the drawings, pages 1/16-16/16 as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**

These elements were available or furnished to this Authority in the following language : which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

**4. ☐ The amendments have resulted in the cancellation of:**

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000415

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-21	YES
	Claims	NO
Inventive step (IS)	Claims 2-21	YES
	Claims 1	NO
Industrial applicability (IA)	Claims 1-21	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)****CITATIONS:**

D1: US 4,692,511 A

D2: AU 80926/98 A

D3: WO 02/14265 A

**EXPLANATION:****NOVELTY:**

Amended claims 1-21 are novel in light of the disclosure of documents D1 to D3.

**INVENTIVE STEP (IS): Claim 1**

The Attorney has argued in her submission with respect to US 4,692,511 that there are no experimental results to support the assertion that the compounds disclosed in the citation are effective for treatment of fibrotic condition.

However given the disclosure in US 4,692,511 that C5a receptor antagonist peptides disclosed there in are particularly useful in the treatment of fibrotic condition idiopathic pulmonary fibrosis, the skilled person would reasonably be expected to use peptides of US 4,692,511 in the treatment of fibrosis with a reasonable expectation of success. Therefore claim 1 would still lack an inventive step.

THERAPEUTIC METHODFIELD OF THE INVENTION

5 This application claims priority from Australian  
provisional patent application No. PS1606, filed on  
8 April 2002.

10 This invention relates to the use of an antagonist  
of a G protein-coupled receptor in the prevention and/or  
treatment of fibrosis, such as the treatment of fibrosis  
associated with myocardial infarction, diabetes, or certain  
pulmonary conditions. In a preferred embodiment the  
antagonist is a C5a receptor antagonist, more preferably a  
cyclic peptide antagonist of the C5a receptor.

15 BACKGROUND OF THE INVENTION

All references, including any patents or patent  
applications, cited in this specification are hereby  
incorporated by reference. No admission is made that any  
reference constitutes prior art. The discussion of the  
20 references states what their authors assert, and the  
applicants reserve the right to challenge the accuracy and  
pertinency of the cited documents. It will be clearly  
understood that, although a number of prior art  
publications are referred to herein, this reference does  
25 not constitute an admission that any of these documents  
forms part of the common general knowledge in the art, in  
Australia or in any other country.

G protein-coupled receptors are prevalent  
throughout the human body, comprising approximately 60% of  
30 known cellular receptor types. They mediate signal  
transduction across the cell membrane for a very wide range  
of endogenous ligands and consequently participate in a  
diverse array of physiological and pathophysiological  
processes, including, but not limited to, those associated  
35 with cardiovascular, central and peripheral nervous system  
reproductive, metabolic, digestive, immunoinflammatory, and  
growth disorders, as well as other cell regulatory and  
proliferative disorders. Agents which selectively modulate

et al. 1997).

The effects of drug-induced and hypertension-induced pulmonary and renal fibrosis in animal models can be prevented or partially reversed by compounds which act  
5 by suppressing inflammatory events and down-regulating lung pro-collagen I over-expression (Iyer et al., 1999a,b).

We have shown that the administration of pirfenidone or spironolactone can prevent and partially reverse cardiac fibrosis and the increase in cardiac  
10 stiffness which occurs in streptozotocin-induced diabetes in rats (Miric G, et al., 2001) It is thought that pirfenidone acts by inhibiting increased TGF- $\beta$  mRNA expression, allowing an increase in expression of metalloproteases which degrade the collagen I laid down  
15 during fibrosis. The mode of action of spironolactone is at present unknown. Spironolactone is a steroid analogue which is primarily used as a diuretic; pirfenidone (5-methyl-1-phenyl-2-(1H)-pyridone), an investigational compound being investigated as an anti-fibrotic agent in a  
20 number of indications.

It would be highly desirable to identify other therapeutically or prophylactically active agents for use in the treatment or prevention of fibrosis.

25 SUMMARY OF THE INVENTION

The overexpression or underregulation of a G-protein-coupled receptor, the C5a receptor, has been implicated in immune-system mediated events such as inflammation. Agents which influence C5a receptor  
30 activity, such as C5a receptor antagonists, have the potential to mediate inflammatory events, and may provide a means of therapeutic or prophylactic intervention, but have not previously been suggested as potential agents in the treatment or prevention of fibrosis.

35 We have now surprisingly found that a cyclic peptide with C5a receptor antagonist has the ability to

ameliorate cardiac fibrosis in an animal model of this condition.

According to a first aspect, the invention provides a method of prevention, treatment or alleviation  
5 of a fibrotic condition, comprising the step of administering an effective amount of an antagonist of a G protein-coupled receptor to a subject in need of such treatment.

The use of any compound having activity as an  
10 antagonist of a G protein-coupled receptor, and particularly as a C5a receptor antagonist, is contemplated, including but not limited to those disclosed in our earlier International patent applications No. PCT/AU98/00490 or No. PCT/AU02/01427 or in International patent applications No.  
15 PCT/US00/11187 by Neurogen Corporation and No. PCT/JP01/06902 by Welfide Corporation, or antibody antagonists such as those disclosed in PCT/US00/24219 or US patent No. 6355245. The entire disclosures of all of these specifications are incorporated herein by this cross-  
20 reference.

More preferably the C5a receptor antagonist is a peptide or a peptidomimetic compound, and more preferably is a cyclic peptide or a cyclic peptidomimetic compound. Even  
25 more preferably the compound is a cyclic peptide or a cyclic peptidomimetic compound of PCT/AU98/00490 or PCT/AU02/01427.

Still more preferably the antagonist is a compound which

- (a) is an antagonist of a G protein-coupled receptor,
- 30 (b) has substantially no agonist activity, and
- (c) is a cyclic peptide or peptidomimetic compound of formula I

Xylocaine to prevent airway spasm, the rats were intubated and a slow injection of bleomycin or saline control was completed. The rats were then rotated gently for about 1-2 minutes to allow the solution to diffuse evenly into both  
5 lungs (Christensen et al 2000). Rats were kept in the fume cupboard until totally recovered, and then monitored for up to 18 days. Body weight, food and water intake, and respiration were monitored daily.

Respiration was elevated as follows: Score 0,  
10 normal respiration; Score 1, increased rate of breathing; and Score 2, mouth open respiration. Rats were euthanased before the end of the experimental period, if they consistently lost more than 10% body weight for 48 hours, had Score 2 respiration or had Score 1 respiration for 48  
15 hours.

At the end of this period the rats were killed by exsanguination under anaesthesia, so that the lungs were clear of blood. For each rat, the left lung was immediately frozen in liquid nitrogen and stored at  $-20^{\circ}\text{C}$  for  
20 quantitative collagen analysis using hydroxyproline assay. The right lung was fully inflated and fixed with 10% formulated formalin by airway gravity fixation at a pressure of 30 cm water for 1 minute. Haematoxylin and eosin (H&E) and Picro Sirius Red (PR) staining for collagen  
25 were performed to assess collagen deposition in the lung. For quantitation of collagen stained with PR, polarized light images were converted to grey scale, and the total number of white pixels (specific for collagen) per image was determined as a percentage of the total pixel area. The  
30 procedure was applied to a total of four fields in the alveolar area and two fields in the peribronchial area and blood vessels per sample (Wang et al, 2000). The largest lobe of the right lung (from 4 lobes) in each rat was chosen. The data was analysed using the program "Sion  
35 Image".

Hydroxyproline assay was performed by the method

Table 1.  
Lung weight and body weight in bleomycin-induced pulmonary  
fibrosis (7-9 days)

Condition	Left lung weight (g)	Body weight (g)	Ratio $\times 10^{-3}$
Normal	$0.507 \pm 0.003$	$240.6 \pm 4.667$	$1.9 \pm 0.36$
Bleomycin	$1.004 \pm 0.04$	$226 \pm 8.083$	$4.47 \pm 0.46^{**}$
Bleomycin + PMX53	$0.974 \pm 0.132$	$228 \pm 7.583$	$4.25 \pm 1.07^{**}$

\*\* :  $P < 0.001$ ,  $n=3$ , compared to normal rats.

Under the microscope, numbers of inflammatory cells, including PMNs, macrophages, lymphocytes etc. were observed in the alveolar spaces, with massive leakage of plasma and red blood cells; this is illustrated in Figure 13a. The size and number of type II AECs in the alveolar spaces was clearly increased, as shown in Figure 13b, while in normal lung, the type II AECs covered only 5 - 10% of the surface area of the alveoli, as shown in Figure 14.

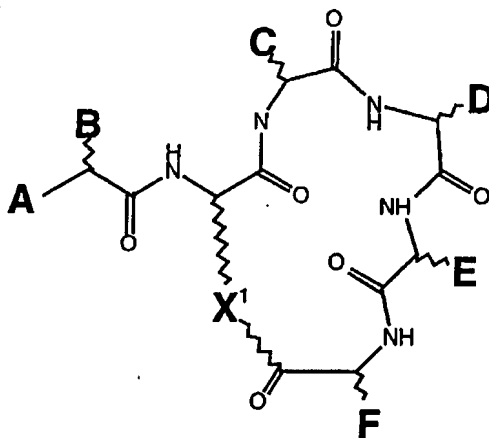
There was no significant difference in histology between drug-treated and non-treated groups. Collagen deposition in bleomycin instillation lungs showed a significant increase compared to normal lungs ( $P < 0.01$ ,  $n=3$ ); saline instillation lungs ( $P < 0.01$ ,  $n=3$ ); and saline instillation with PMX53-treated lungs ( $P < 0.01$ ,  $n=3$ ). However, there was no significant difference between the drug-treated group and non-treated group ( $P > 0.01$ ,  $n=4$ ). These results are summarised in Figure 15.

## 2. Pulmonary fibrosis

Eighteen days after intra-tracheal instillation of bleomycin, the degree of oedema was reduced in bleomycin-instilled lungs, and the lung/body weight ratio did not

CLAIMS

1. A method of prevention, treatment or alleviation of a fibrotic condition, comprising the step of  
 5 administering an effective amount of an antagonist of a C5a receptor to a subject in need of such treatment, in which the antagonist is a peptide or a peptidomimetic compound.
2. A method according to claim 1, in which the antagonist is a cyclic peptide or a cyclic peptidomimetic  
 10 compound.
3. A method according to claim 1 or claim 2, in which the inhibitor is a compound which
- a) is an antagonist of a G protein-coupled receptor,  
 15 b) has substantially no agonist activity, and  
 c) is a cyclic peptide or peptidomimetic compound of formula I



20 where A is H, alkyl, aryl, NH<sub>2</sub>, NH-alkyl, N(alkyl)<sub>2</sub>, NH-aryl, NH-acyl, NH-benzoyl, NHSO<sub>3</sub>, NHSO<sub>2</sub>-alkyl, NHSO<sub>2</sub>-aryl, OH, O-alkyl, or O-aryl;

25 B is an alkyl, aryl, phenyl, benzyl, naphthyl or indole group, or the side chain of a D- or L-amino acid, but is not the side chain of glycine, D-phenylalanine, L-

homophenylalanine, L-tryptophan, L-homotryptophan, L-tyrosine, or L-homotyrosine;

C is the side chain of a D-, L- or homo-amino acid such as glycine, alanine, leucine, valine, proline,  
5 hydroxyproline, or thioproline, but is not the side chain of isoleucine, phenylalanine, or cyclohexylalanine;

D is the side chain of a neutral D-amino acid, but is the side chain of glycine or D-alanine, a bulky planar side chain, or a bulky charged side chain;

10 E is a bulky substituent, but is not the side chain of D-tryptophan, L-N-methyltryptophan, L-homophenylalanine, L-2-naphthyl L-tetrahydroisoquinoline, L-cyclohexylalanine, D-leucine, L-fluorenylalanine, or L-histidine;

15 F is the side chain of L-arginine, L-homoarginine, L-citrulline, or L-canavanine, or a bioisostere thereof; and

X is  $-(CH_2)_nNH-$  or  $(CH_2)_nS-$ , where n is an integer of from 1 to 4;  $-(CH_2)_2O-$ ;  $-(CH_2)_3O-$ ;  $-(CH_2)_3-$ ;  $-(CH_2)_4-$ ;  
20  $-CH_2COCHRNH-$ ; or  $-CH_2-CHCOCHRNH-$ , where R is the side chain of any common or uncommon amino acid.

4. A method according to claim 3, in which n is 2 or 3.

5. A method according to claim 3 or claim 4, in which  
25 A is an acetamide group, an aminomethyl group, or a substituted or unsubstituted sulphonamide group.

6. A method according to claim 5, in which A is a substituted sulphonamide, and the substituent is an alkyl chain of 1 to 6, or a phenyl or toluyl group.

30 7. A method according to claim 6, in which the substituent is an alkyl chain of 1 to 4 carbon atoms.

8. A method according to any one of claims 3 to 7, in which B is the side chain of L-phenylalanine or L-phenylglycine.

35 9. A method according to any one of claims 3 to 8, in which C is the side chain of glycine, alanine, leucine,

valine, proline, hydroxyproline, or thioproline.

10. A method according to any one of claims 3 to 9, in which D is the side chain of D-Leucine, D-homoleucine, D-cyclohexylalanine, D-homocyclohexylalanine, D-valine, D-norleucine, D-homo-norleucine, D-phenylalanine, D-tetrahydroisoquinoline, D-glutamine, D-glutamate, or D-tyrosine.

11. A method according to any one of claims 3 to 10, in which the antagonist is a compound which has antagonist activity against C5aR, and has no C5a agonist activity.

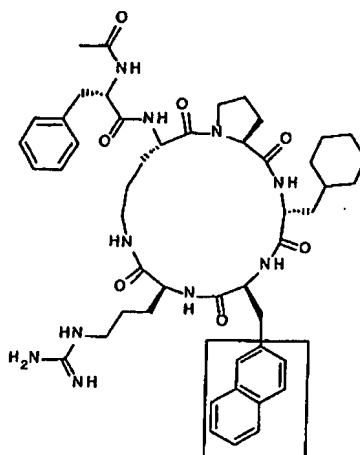
12. A method according to any one of claims 1 to 11, in which the inhibitor has potent antagonist activity at sub-micromolar concentrations.

13. A method according to any one of claims 1 to 12, in which the compound has a receptor affinity  $IC_{50} < 25 \mu M$ , and an antagonist potency  $IC_{50} < 1 \mu M$ .

14. A method according to any one of claims 1 to 13, in which the compound is selected from the group consisting of compounds 1 to 6, 10 to 15, 17, 19, 20, 22, 25, 26, 28, 30, 31, 33 to 37, 39 to 45, 47 to 50, 52 to 58 and 60 to 70 described in International patent application No. PCT/AU02/01427.

15. A method according to claim 14, in which the compound is AcF[OP-DCha-WR] (PMX53 compound 1), AcF[OP-DPhe-WR] (compound 33), AcF[OP-DCha-FR] (compound 60) or AcF[OP-Dcha-WCit] (compound 45).

16. A method according to claim 15, in which the compound is PMX53, having the formula



17. A method according to any one of claims 1 to 16, in which the fibrotic condition is selected from the group consisting of multiple sclerosis, proliferative vitroretinopathy, macular degeneration, scleroderma, sclerosing peritonitis, fibrosis arising from trauma, burns, chemotherapy, radiation, infection or surgery and fibrosis of the kidney, liver, heart or lungs, chronic hypertension and diabetes mellitus.
18. A method according to claim 17, in which the fibrotic condition is cardiac fibrosis or pulmonary fibrosis.
19. The use of a C5a receptor antagonist as defined in any one of claims 1 to 16 for the manufacture of a medicament for use in the treatment of a fibrotic condition.
20. A use according to claim 19, in which the fibrotic disorder is selected from the group consisting of multiple sclerosis, proliferative vitroretinopathy, macular degeneration, scleroderma, sclerosing peritonitis, fibrosis arising from trauma, burns, chemotherapy, radiation, infection or surgery and fibrosis of the kidney, liver, heart or lungs, chronic hypertension and diabetes mellitus.
21. A use according to claim 20, in which the fibrotic condition is cardiac fibrosis or pulmonary fibrosis.

Rec'd PCT/PTO

07 OCT 2004

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference VS:CE:FP17710	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/AU03/00415	International filing date (day/month/year) 7 April 2003	(Earliest) Priority Date (day/month/year) 8 April 2002
Applicant PROMICS PTY LIMITED et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title, ☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows: Use of CSa receptor antagonist in the treatment of fibrosis

5. With regard to the abstract, ☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure

☐ because this figure better characterizes the invention

☒ None of the figures

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/00415

**A. CLASSIFICATION OF SUBJECT MATTER**Int. Cl.<sup>7</sup>: A61K 38/04, A61K 39/395, A61K 38/08; A61P 13/12, A61P 9/10, A61P 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Derwent WPAT and Medline keywords: Fibrot?, Fibros?, myocardial()infarction, diabetes, C5a, C5aR, receptor?, antagonist, antibod? and like terms.

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,692,511 A (Hahn Gary. S.) 8 September 1987 See abstract	1-13
Y	AU 80926/98 A (THE UNIVERSITY OF QUEENSLAND) 19 January 1999 See pages 1 and 2	1-13
X	WO 02/14265 A (WELFIDE CORPORATION) 21 February 2002 See abstract	1-13



Further documents are listed in the continuation of Box C



See patent family annex

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;"

document member of the same patent family

Date of the actual completion of the international search

27 May 2003

Date of mailing of the international search report

19 JUN 2003

Name and mailing address of the ISA/AU

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/AU03/00415**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	4692511	EP	305615
AU	80926/98	WO	9900406
		EP	1017713
WO	200214265	AU	200177751
		EP	1308438
END OF ANNEX			